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Production **of Drug and Condiment Plants**



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INTEREST continues from year to year in the possibility of growing medicinal and condiment plants for profit. Many of them are grown abroad under soil and climatic conditions similar to those in parts of this country, and large sums are expended annually for the imported products.

Our dependence on foreign sources for botanical drugs and condiments was clearly shown during the two world wars—as soon as hostilities broke out in Europe shortages developed here. The supplies on hand here are generally limited and soon exhausted, and in such circumstances their market value increases rapidly. This stimulates the recurring interest in growing the special crops from which they are obtained.

To reduce our dependence on importations and to provide even a small additional source of income to farmers when conditions are favorable, the cultivation of drug and condiment plants should be encouraged whenever circumstances indicate that the enterprise might be successful.

This bulletin supersedes Farmers' Bulletin No. 663, Drug Plants Under Cultivation.

PRODUCTION OF DRUG AND CONDIMENT PLANTS

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ECONOMIC BACKGROUND

WELL over 200 species and varieties of drug and condiment plants are collected from all parts of the world for use in this country. The number needed to produce the most essential products, however, is relatively small. To grow the essential drug plants adapted to this country would require not more than a few thousand acres. The leaf and seed condiments that can be grown here are used in much larger quantity than the drugs, and while their production would require a much larger acreage it would be insignificant compared with that of the staple crops.

Only people in the most favored circumstances for growing, harvesting, and handling such special crops, however, will find production profitable, even in times of good prices. On the other hand, there is the possibility that greater uniformity, reliability, and quality in some of these special products grown here during periods of high prices may develop a permanent market outlet in competition with cheaper foreign products.

The problems presented by the cultivation of such special crops are probably more difficult and more numerous than those encountered in the production of many others. These crops are subject to as many disease hazards and other risks as those generally grown and are similarly affected by variations in soil and climatic conditions. They require intelligent care and handling and, on the whole, more hand labor. They are subject to the same laws of supply and demand, and their products must conform to the consumer's fancy and to definite trade requirements.

These problems must be considered and their solution found before it can be determined whether such crops can be grown profitably in any region. In undertaking their cultivation it is essential to know that the species selected will do well on the soil and in the climate of the new locality.

Assuming, however, that these conditions are suitable, it does not necessarily follow that these plants can be produced at a profit. The value of the land, the cost and availability of labor, and the possible returns from other crops for which the land could be used are all factors to be considered. Since the relative importance of these factors is not the same in all localities, a crop might prove to be profitable in one location and unprofitable in another. Unqualified statements concerning the ease and profitableness of growing drug and condiment plants, therefore, should not be taken too seriously.

A large number of drug and condiment plants can be grown in the United States, but the same plants are not equally adapted to the soil and climatic conditions of different sections. In many cases it cannot be foretold which are the most suitable plants for a particular situation without field trials. In such cases it is well to select for cultivation plants that thrive elsewhere under conditions that most closely resemble those of the locality in which it is proposed to grow them. The success with which ordinary field or garden crops can be grown will in general indicate the possible suitability of a given locality for growing many of these special plants. Some of the leaf and seed condiments have long been grown in home gardens in many localities for home use in flavoring foods or for sale in city markets.¹ The present bulletin discusses the culture, harvesting, curing, processing, and marketing of drug and condiment plants chiefly as farm crops for the commercial market.

THE MORE IMPORTANT PLANTS

The plants discussed in this bulletin include many that are of relatively small importance compared with other crops, although their products may be in more or less continued use in medicinal preparations or for flavoring or scenting a variety of well-known products. Only a

¹ Information on the growing of condiment plants on such a small scale is available in *Farmers' Bulletin 1977, Savory Herbs: Culture and Use*.

few are of such importance in the daily national economy that lack of them in periods of emergency would cause real concern. Their cultivation, however, becomes necessary in such periods to relieve the acute shortages that develop. Since only a small acreage is needed to produce them in adequate quantity, the growing of these crops during such periods causes little interference with the production of vital foods, fibers, and other important agricultural products. What was learned about their production during the world wars will be helpful to future growers who attempt to establish them on their farms as supplemental sources of cash income.

The drug plants included in the small group of the more important species adapted to culture in the United States are belladonna, digitalis, henbane, and stramonium.

Among the condiment plants that are grown here more or less, from year to year or during periods of shortages, are mustard, cayenne and paprika peppers, sage, and caraway.

The well known and popular spices—black pepper, cinnamon, cloves, allspice, vanilla, nutmeg, and mace—are not here discussed. They are the products of slow-growing tropical vines, shrubs, or trees not adapted to the United States, and their harvesting requires a great deal of cheap hand labor.

YIELDS

The yields obtained from drug and condiment plants naturally vary with the suitability of the situation selected for cultivation. Even in the same locality wide variations in yield result from differences in the local conditions of soil and drainage and from year-to-year variations in the weather. The skill of the grower and the care and attention he bestows on his crop also affect yields in no small measure.

Not all the plants mentioned in this bulletin have been grown on a scale large enough to permit making estimates of yields with any accuracy. Acreage yields calculated from the product of small garden plots are generally untrustworthy, since in such plots the plants are usually more favorably situated with respect to soil and are given better culture than when under field conditions. Moreover, as the size of the area increases, it becomes more difficult to maintain an approximately perfect stand and to protect the crop from the ravages of insects or other destructive agencies. The returns from small experimental areas therefore can at most be regarded only as an indication of the yield that will be obtained under favorable conditions. The prospective grower will do well to proceed cautiously until he has determined for himself what he can expect in his particular location.

PROPAGATION, CULTURE, AND GENERAL HANDLING

The special details of cultivation for each of the plants treated are given under the discussion of the individual species, beginning on page 10. Suggestions of general application, however, are here brought together in order to avoid unnecessary duplication. A number of the species considered can be grown easily from seed, others from cuttings or by division of roots or crowns. Many wild medicinal plants are

much more difficult to propagate from seed than the species commonly grown in gardens. Likewise, some of the species now grown abroad and suitable for cultivation in this country are not easily propagated and require special conditions for good results. Some species that require partial shade must be grown in more or less open woodland or under specially constructed lath shade (fig. 1).



FIGURE 1.—Plants growing under a lath structure providing partial shade.

Seeds of the condiment plants are generally available from commercial seedsmen in this country. Seeds of some of the medicinal plants, however, though not regularly listed in the catalogs of seedsmen, can sometimes be obtained from dealers who make a specialty of these species. Young plants or roots are frequently available from nurseries or dealers in hardy ornamentals, but stock thus obtained is usually too expensive, except for small trial plantings that later can become the source of larger quantities of propagating stock at small cost. It will pay to consult the catalogs of a number of dealers and to select varieties for propagation carefully. In cases where ornamental varieties are listed, always specify the medicinal variety in ordering. The ornamentals may be of doubtful or of no medicinal value.

Propagation

Only a relatively small number of these special plants can be satisfactorily grown from seed sown in the field. In many cases the seed method is uncertain, and with some plants it is wholly inadvisable. In order to insure a good stand of thrifty plants and to avoid undue competition with weeds when the plants are small, it is frequently necessary to make the sowings in a greenhouse, hotbed, or coldframe and later transplant the seedlings to the field. In this respect the propagation of

these special plants is on the whole no different from that of various garden and truck crops.

The preparation of the soil is of prime importance, whether the seed is sown in the open or under cover. Many seeds, especially very small ones, do not germinate well in soils that are heavy, cloddy, or of coarse texture. A seedbed prepared by thoroughly mixing equal parts of garden soil, well-decayed leafmold, well-rotted manure, and clean sand will be suitable for the germination of most seeds. Steam sterilization of the soil in seedbeds will kill weed seeds and reduce loss of seedlings from damping-off fungi.²

The depth of sowing is largely governed by seed size and soil character. In general the smaller the seed the less the depth of sowing. Seed should be covered more deeply in light sandy soil than in heavy clay soil. Fall-sown seed also requires a greater depth of covering than that sown in the spring. The exact quantity of seed needed for sowing a given area cannot be definitely stated. The same kind of seed from different sources will be found to vary widely in viability, hence the percentage of germination should be ascertained in advance of sowing and the quantity sown regulated accordingly. In general, the heavier the soil the larger the quantity of seed required. If the plants are to be thinned out or transplanted, or if they are especially subject to insect attacks, the use of ample seed is generally advisable.

When plantings are made in open ground it is preferable to sow the seed in rows or drills to facilitate cultivation. Seed drills such as are commonly used by market gardeners can be used to advantage. This favors good germination, since with the drill the depth of sowing is more uniform and the soil is compacted over the seeds. The distance between rows is determined in part by the size the plants attain at maturity, but depends also upon the method of cultivation.

Many species can be successfully propagated only by cuttings or divisions. Cuttings that are rooted in sand in winter or early spring require greenhouse or hotbed facilities. Plants that have large crowns may in some cases be divided and replanted. The use of other plant parts, such as rhizomes and stolons, is also practical. By such means the plantings can be enlarged greatly in one season, depending on the species and the part of the plant used.³

Culture

There are few set rules for the cultivation of special plants. The grower must rely on his experience with other plants as a guide in many of the details. Some general rules are important: (1) Keep the soil free from weeds; (2) whenever possible space the rows so as to permit the use of labor-saving methods of cultivation; and (3) set the plants in checkrows when this will reduce cultivation costs and minimize the problem of obtaining hand labor.

² For detailed information see Farmers' Bulletin 1629, Steam Sterilization of Soil for Tobacco and Other Crops. Available in libraries only.

³ Detailed information on the use of these several types of propagation is available in Farmers' Bulletin 1743, Hotbeds and Coldframes; and Farmers' Bulletin 1977, Savory Herbs: Culture and Use.

Harvesting

The roots of drug plants are usually collected in fall or at the end of the growing season, but they may also be dug while still dormant early in spring. Roots collected during the growing season often shrink excessively in drying and do not yield the most desirable product. On small areas either a spade or a potato fork is a suitable tool for digging most roots, but on large areas a plow is more practical.

Most roots require thorough washing, and when the quantity is small this is easily done by placing them on a wire-mesh frame and turning a garden hose on them. Large quantities may have a strong spray of water directed on them while passing slowly through a revolving cylinder of hardware cloth built on a metal frame and mounted at a moderate angle.

Herbs, including leaves, stems, and flowering tops, are usually harvested when the plants are in flower. Picking the leaves by hand in the field is a slow process. In some cases it will save time to cut the entire plant and strip the leaves after bringing the plants in from the field. If the entire herb is wanted, it is preferable to cut the plants high enough above the ground not to include too much of the coarse stem material. Leaves or the whole herb, especially if used as condiments, should be free from adhering soil. It may be necessary to wash them before they are dried.

Some flowers are gathered while scarcely open and others as soon after opening as possible. In general they should be carefully dried in the shade to prevent discoloration. Because hand picking is very laborious, mechanical devices similar to a cranberry scoop (fig. 2, *A*) or a seed stripper (fig. 2, *B*) can often be used to good advantage. When passing these, teeth forward, through the plants, the comb snaps off the flower heads and they fall into the box. They can then be emptied into suitable containers.

Seeds are harvested as soon as most of those on the plant have ripened and before the pods or seed capsules have opened. To reduce loss from shattering, it is well to harvest the seedlike fruits of condiment plants, such as anise, caraway, coriander, and fennel, just before they are fully ripe. When these are grown in large fields they must be harvested

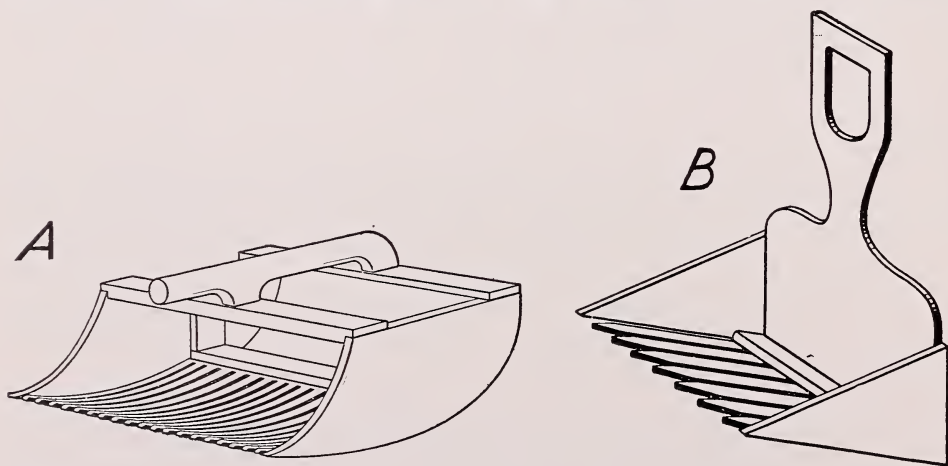


FIGURE 2.—*A*, Berry scoop suitable for harvesting flower heads of large size. *B*, Seed stripper that can be used for gathering flower heads.

by machine. In regions where clear weather prevails during the harvest periods a combine has in some cases proved practical and economical. The machinery used for threshing and cleaning ordinary seed crops will frequently serve a similar purpose for seeds of medicinal and condiment plants, provided the proper adjustments are made.

Handling these special crops at harvesttime to obtain the marketable product in the best condition is frequently the most difficult operation the grower has to perform. Adequate facilities and labor should be available at this stage. Since in most cases the harvest must be completed in a short period, it is advisable, where more than one species is grown, to plant those that will not need to be harvested at the same time.

Drying

In all cases except where the fresh material is distilled to obtain the volatile oil, all usable parts of plants must be carefully dried. The method of drying depends on the nature and quantity of the material. The seed condiment crops are generally handled by very practical methods, which are described in the individual discussions beginning on page 10. Roots, especially the fleshy kind, require the most time to dry and must be sliced either crosswise or lengthwise, or both, to hasten the process and to prevent molding or fermenting. Herbaceous parts dry more rapidly in most cases, but the presence of heavy succulent stems or thick leaves makes the process much more difficult.

If the drying is not done in direct sunlight or if the weather is unfavorable the material may be spread thinly on wooden floors in well-ventilated rooms. Placing it on shallow, wire-bottomed trays stacked with adequate space between them assures faster drying and better quality. If slow natural drying is not practical the process can be hastened by using heat from a stove or steam pipes. Thorough movement of air through proper ventilators is beneficial, and the use of forced draft with fans assures still faster drying. Stirring the material occasionally and shifting it about in the room results in more uniform drying.

Growers who have several acres of such crops from year to year generally provide structures specially designed for handling the material with the lowest cost and least delay. After the material is thoroughly dry remove large stems from the herbs and clean the seed with a fanning mill to remove dirt and light immature seed.⁴

Distillation of volatile oils

The volatile oils obtained from many aromatic plants by steam distillation are often the only or the most important products derived from them. The distilling equipment necessary⁵ includes a boiler, a retort or vat, a condenser, and a receiver.

The retort is usually a circular wooden or galvanized-iron vat, 6 to 9 feet deep and 6 to 7 feet in diameter, with a removable lid that can be clamped down tight when the still is in operation. A steam pipe

⁴For more complete information, see Farmers' Bulletin 1231, Drying Crude Drugs. Available in libraries only.

⁵All stills, regardless of the purpose for which they are intended, must be registered with the United States Bureau of Internal Revenue. For the required application forms communicate with the collector of internal revenue in the district where the still is to be operated.

leads from the boiler to the bottom of the retort, and from the top of the retort a somewhat larger pipe leads to the condenser.

The condenser consists essentially of a coil of galvanized-iron pipe in a tank of similar material. The tank is kept filled with flowing cold water while the still is in operation. The plant material, sometimes in partially dried condition, is packed firmly into the retort. The steam admitted into the retort from the boiler volatilizes the oil in the plants and passes with it into the condenser. Both pass in liquid form from the condenser into the receiver, which is filled with water. There they separate into two layers.

The receiver is a metal vessel of convenient size provided with an outlet through which the water from the condenser can run off through a gooseneck as fast as it comes in. Most oils are lighter than water and collect in a layer on the surface; others are heavier and settle at the bottom of the receiver. The details of construction of the receiver depend therefore on whether the oil distilled is lighter or heavier than water.

The general arrangement of these several parts may vary according to conditions, but it is desirable to assemble the whole equipment in such way as to permit installing the outfit at the lowest cost and operating it with the least labor.

When a considerable acreage of a volatile-oil crop is grown the distilling equipment should consist of two retorts to be operated with one condenser. While a charge is being distilled in one of the retorts the other can be emptied and recharged. A two-retort distilling unit installed, including a boiler and a derrick or crane for lifting the charge in and out of the retort, ordinarily costs \$2,000 to \$4,000 (fig. 3).⁶

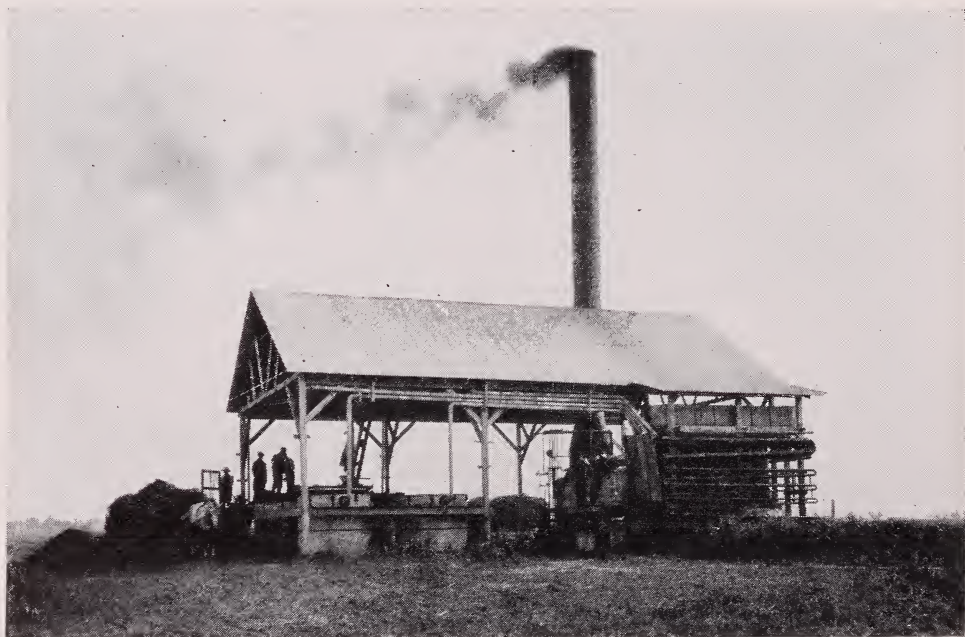


FIGURE 3.—A volatile-oil distilling unit used in the production of peppermint oil.

⁶ Distilling equipment is illustrated and its construction and operation described in *Farmers' Bulletin No. 1988, Mint Farming*.

Baling, packaging, and storing

Sometimes herbaceous material may appear to be entirely dry, but parts of stems may contain considerable moisture that would mold if the stems were packed or baled in such condition. If the material is allowed to remain for several days in a pile on a clean floor the moisture will tend to equalize throughout the mass and thus reduce the danger of spoilage. The leafy parts, which might otherwise be brittle, will then not break or powder when the product is packaged.

As a rule it is best to send the finished product to market as soon as possible so as to avoid lengthy storage, during which damage by moisture, insects, or rodents might occur. Leafy drugs are usually not acceptable unless in reasonably whole condition. Such products can be packed firmly in cardboard cartons lined with paper and sealed to prevent spillage of the finer particles. In the case of condiment herbs this type of package will also prevent loss of flavor.

Dried herbs can also be baled to advantage. For small lots the small type of hand-operated baler often used for baling waste paper is satisfactory. For handling large quantities there are various types of commercial balers. The bales should be wrapped in burlap or heavy paper. Dried roots and seed are best marketed in clean bags.

If storage of herbaceous material is necessary a clean dry room should be provided. Dampness and humidity can be very damaging. Protection of many of the seeds against rodents and insects is important. Volatile oils should be stored in tin cans or bottles, always completely filled and well closed. Some oils are damaged by light, therefore amber bottles should be used. In general, oils are best stored in rooms with moderate temperatures and subdued light.

Marketing

The commercial grower of drug and condiment plants cannot give too much attention to the problem of finding a satisfactory market for his products. Growers who live near cities in which dealers in these plants are located or in sections where the plants can be collected in the wild may be able to find a local market. In many situations, however, there is no local market for such plants or their products in quantity.

In such cases the grower should send samples of his product to dealers in botanicals or volatile oils, to manufacturers of pharmaceutical preparations, or to spice manufacturers, and request them to name a price at which they will purchase his crop. The material for the samples should not be specially selected nor so prepared as to represent a quality higher than that of the whole lot, since this would give the purchaser just cause for reducing the price on delivery or for rejecting the whole shipment. It is well to send samples to a number of dealers, since prices will vary with stocks on hand and the trade prospects.

Before selling, it is well to learn the state of the wholesale market. The prices to producers are, of course, always much lower than either the wholesale or the retail price; nevertheless, the grower who is informed with respect to the wholesale market will be in position to judge of the fairness of the prices offered by dealers.

By always supplying a well-prepared, carefully selected product of high quality, growers can sometimes build up a trade in their particular product at a material advance over the prevailing market price. Dealers

and manufacturers also sometimes make contracts with reliable growers to take the entire crop of a particular plant, thus insuring a definite market and usually satisfactory prices. On the whole this is the best arrangement, at least for an inexperienced grower. The price is not always as high as he could get on the open market, but it removes much of the uncertainty in the undertaking.

The demand for the products of a number of these plants may be variable or exceedingly limited, and hence production on a large scale would be inadvisable. Although for others the demand may be fairly constant and steady, the product of a very few acres of good land could probably fully satisfy it. It is evident that the cultivation of any considerable acreage might easily result in overproduction and unprofitable market prices.

Few if any of the medicinal plants are used in quantities sufficient to make them a promising crop for general cultivation. Some are obtained in sufficient quantity from the wild. Many of the common ones that can be grown and prepared for market with little difficulty bring but a few cents a pound, and their cultivation offers little prospect of profit. A number of them must be given care for 2 years or more before a crop can be harvested, and the production of such crops offers little encouragement to an inexperienced grower who looks for quick returns and large profits from a small investment. Medicinal and condiment plants grown in small quantities and without regard to the various conditions that affect their value are likely to be of poor quality and so unattractive to dealers and manufacturers that they will not be salable at a price sufficient to make production profitable.

CULTIVATION OF INDIVIDUAL SPECIES

The drug and condiment plants about which information is most frequently requested are discussed in the following pages. All are adapted to the conditions of soil and climate found in some sections of the United States. The majority, however, are of minor importance commercially, and in most cases these have not been grown in this country long enough, if at all, to furnish reliable cultural information. Species that have been under cultivation here continuously for some time or have been grown during periods when economic conditions were favorable are discussed in greater detail.

Persons interested in the possibilities of growing drug and condiment plants on their farms ask for information about the usual sources of the products obtained, the quantities in which they are used, and the prices they command. They want to know what plants are adapted to the local conditions and which ones fit best into the prevailing type of farming. Finally, they need information on how such plants are grown, harvested, and prepared for market.

Trade and agricultural information is assembled in tables 1 and 2, to give a general idea of the possibilities of each species in a particular locality. Listing the countries from which the imported products are obtainable serves to emphasize how quickly the normal trade in these can be affected by world disturbances. Where no import statistics are given the figures are not available or the domestic requirements are supplied by the collection of wild plants or by their cultivation in the regions indicated. Approximate market values of the products during 1933 and 1938 are given; 1938 was the last prewar year in which

TABLE 1.—*Summary of trade information on medicinal and condiment plants that are or can be grown in the United States*

Plant	Marketable parts or products	Trade information			
		Importations		Market values per pound, ³ range or average	
		Average yearly, 1936-38 ¹	Principal sources ²	1933	1938
		<i>Pounds</i>		<i>Dollars</i>	<i>Dollars</i>
Aconite.....	Roots.....	11,228 (1937-39).....	Italy, Spain, Germany, France.....	Root, 0.14.....	0.28-0.36
Althea.....	do.....		Europe.....	Root, .13-.23.....	.30-.32
Angelica.....	Roots and seed.....	44,329 (root and seed, 1938).....	Germany, Belgium.....	Root, .10-.22.....	Root, .16-.31
Anise.....	Seed ⁴ and seed oil.....	494,003 (estimated seed equivalent of imported oil, 13,000,000).....	Bulgaria, Spain, China, France, Mexico, Europe.....	Seed, .12-.14.....	Seed, .13-.17
Arnica.....	Flowers and roots.....			Flowers, .07-.15; root, .40-.42.....	Flowers, .28-.35; roots, .38-.45
Basil.....	Herb and herb oil.....		do.....	Leaves, .15; roots, .13.....	Leaves, .13-.17; roots, .11-.13
Belladonna.....	Herb and roots.....	218,414.....	Yugoslavia, Italy, U.S.S.R., Hungary.....	Leaves, .09-.10.....	Root, .10-.11
Bonsect.....	Herb.....		Europe.....	.40-.60.....	.30-.39
Burdock.....	Roots and seed.....	139,596.....	Hungary, Yugoslavia, U.S.S.R., Belgium.....	Hungarian or German, .13-.17; Roman, .24-.70.....	Hungarian or German, .18-.30; Roman, .24-.32
Calendula.....	Flowers.....		Netherlands, Poland, U.S.S.R., Denmark.....	Seed, .09.....	Seed, .22-.27
Camomile (German, or Hungarian, and Roman).....	Seed ⁴ and seed oil.....	Seed, 6,271,729 (estimated seed equivalent of oil used, 200,000).....	Brazil.....	.03-.04.....	.03-.04
Caraway.....	Seed.....	140,181,499.....	Japan, Egypt, Mexico.....	14-.16.....	.17-.19
Castor-bean.....	Flowering herb.....		France, British India.....	.14-.24.....	.15-.21
Catnip.....	Dried fruit.....	1,652,345.....	Europe.....	.33-.70.....	.11-.17
Cayenne.....	Seed ⁴	1,218,341.....	Morocco, Europe, United Kingdom, British India.....	.55-.60.....	.25-.27
Celery.....	Seed and corm.....			Seed, .06.....	Seed, .04-.09
Coleheum.....	Seed ⁴ and seed oil.....	Seed, 2,022,751.....			
Coriander.....	Seed.....	902,967.....	Mediterranean region in Europe and Africa.....	.06-.29.....	.09-.10
Cumin.....	Seed ⁴		Europe.....	.09-.16.....	.13-.20
Dandelion.....	Roots.....		Western Europe.....	.25.....	.40-.65
Digitalis.....	Leaves.....	55,489.....		Seed, .08.....	Seed, .07-.09; oil, 3.50-4.10
Dill.....	Herb, seed, ⁴ and herb oil.....				.20-.27
Echinacea.....	Roots.....			.15-.21.....	.10-.12
Elecampane.....	do.....			.05-.08.....	

See footnotes at end of table.

TABLE 1.—*Summary of trade information on medicinal and condiment plants that are or can be grown in the United States—Continued*

Plant	Marketable parts or products	Trade information			
		Importations		Market values per pound, ³ range or average	
		Average yearly, 1936-38 ¹	Principal sources ²	1933	1938
Fennel.....	Seed ⁴ and seed oil.....	Seed, 266,230.....	British India, Iraq, Rumania, Italy, France.	Seed, 0.11.....	<i>Dollars</i> Seed, 0.07-0.19
Gentian.....	Roots.....	507,392.....	Yugoslavia, France, Italy, Spain, Portugal.	.07-.18.....	.09-.14
Ginger.....	Rhizome.....	837,253 (1937-38).....	China, Jamaica, British West Africa, British India.	.17.....	.06-.16
Ginseng.....	Roots.....			2.00-6.00.....	10.00-11.00
Goldenseal.....	Roots and herb.....			Roots, .55-.90.....	Roots, 2.95-3.85
Henbane.....	Leaves or tops.....	102,569.....	Egypt, U.S.S.R., Hungary.	.10.....	.15-.20
Horehound.....	Leaves and tops.....			.06-.07.....	.09-.10
Larkspur.....	Seed.....		Southern Europe.	23-.25.....	30-.35
Lavender.....	Flowers and oil from flowering tops.....	Flowers, 6,727; oil, 164,752.....	France, United Kingdom.	Flowers, .14-.36; oil, 1.50-3.50.....	Flowers, .35-.55; oil, 2.00-5.00
Licorice.....	Roots.....	67,314,941 (1937-38).....	Turkey, U.S.S.R., Near East, Mediterranean region.	.05.....	.04-.18
Lobelia.....	Herb and seed.....			Herb, .12-.25; seed, 21-.32.....	Herb, .13-.18; seed, .35-.45
Lovage.....	Root and herb oil.....			Root, .15-.25.....	Root, .55-.65
Marjoram.....	Leaves and flowers.....	109,078 (1936-37).....	France, Algeria, Mexico.	.16-.50.....	.15-.17
Melissa.....	Leaves and herb oil.....				
Mustard.....	Seed.....	12,364,126.....	United Kingdom, France.	.07.....	.04-.10
Orris.....	Roots.....	456,201.....	Italy, Morocco.	.08-.13.....	.10-.14
Paprika.....	Dried fruit.....	6,317,230.....	Hungary, Spain, Portugal.	.18-.32.....	.20-.29
Parsley.....	Leaves, seed, and roots.....			Herb, .08-.09; oil, 1.10-2.00.....	Herb, .07-.14; oil, 1.40-1.50
Pennyroyal.....	Herb and herb oil.....			Oil, 1.70-3.40.....	Oil, 2.00-2.65
Peppermint.....	Leaves and herb oil.....	Oil, 2,482.....	U.S.S.R., United Kingdom.	.25-.30.....	.35-.45
Pinkroot.....	Roots.....			Roots, .05-.06.....	Roots, .07-.08
Pokeroot.....	Roots and fruit.....			.05.....	.05-.07
Sage.....	Leaves and small stems.....	1,632,890.....	Yugoslavia, Italy.	.29-.45.....	.50-.75
Senega.....	Roots.....				
Sesame.....	Seed and seed oil.....	Seed (1937-38), 9,940,599; oil (1938-39), 5,279,699.	China, British India, Japan.		

Spearmint.....	Leaves and herb oil.....			Leaves, .16-.22; oil, .90-1.45.	Leaves, .18-.20; oil, 1.65-1.75
Stramonium.....	Leaves and seed.....	Leaves, 299,879.....	Hungary, Italy, Yugoslavia, Germany, U.S.S.R.	Leaves, .12; seed, .09.....	Leaves, .10-.14; seed, .09-.10
Tansy.....	Herb and herb oil.....			Herb, .12-.13.....	Herb, .18-.20; oil, 4.25-5.75
Tarragon.....	do.....				Herb, .22-.30
Thyme.....	do.....	Herb, 191,179 (1936-37).....	France, Italy, Greece.....	Herb, .06-.15.....	Herb, .14-.19; oil, .85-1.45
Valerian.....	Roots and root oil.....	Oil, 10,514.....	France, Netherlands Indies.	Root, .12-.15.....	Root, .09-.12
Vetiver.....	do.....				
Wintergreen.....	Herb and herb oil.....			Oil, 2.65-8.00.....	Oil, 3.05-8.00
Wormseed (American).....	Seed and herb oil.....			Seed, .06-.07; oil, 2.00-2.35.	Seed, .10-.11; oil, 2.50-2.70
Wormwood.....	Herb and herb oil.....			Herb, .08-.09; oil, 3.00-3.25.	Herb, .08-.09; oil, 2.65-3.30

¹Or for another period indicated when statistics for 1936-38 were not available.

²During the period indicated for column 3.

³Values for 1933 and 1938 given to show the trend in the 5-year period preceding the outbreak of war in Europe in 1939.

⁴Botanically the fruit of the plant, but known in the trade as seed.

TABLE 2.—Summary of agricultural information on medicinal and condiment plants that are or can be grown in the United States

Plant	Agricultural information				Remarks on handling and commercial possibilities
	Domestic production	Areas possibly suitable for commercial production	Probable acre yield of marketable product ¹	Estimated area required to produce the average quantity imported ²	
Aconite.....	None.....	Northern States; mountain areas of northern California.	<i>Pounds</i> 400-500.....	<i>Acres</i> 25.....	Propagation difficult.
Althea.....	do.....	New England, Northeastern States.	800-1,000.....		
Angelica.....	do.....	Northern and North Pacific Coast States.			
Anise.....	In gardens for local use; occasional small acreage in the West.	Limited areas on west coast and in North Central States; in irrigated valleys in Southwest as winter crop.	400-500.....	Seed, 1,000; oil, 26,000....	Cultivated as truck crop; harvested like small grains.
Arnica.....	None.....	Mountain meadows in Western States.			
Basil.....	In gardens.....	Wherever vegetable crops are grown.	Herb, 2,000-4,000; oil, 20-40.....		
Belladonna.....	Considerable when price is high.	Northern and Pacific Coast States.	Herb, 500-1,000; roots, 150-350.....	360.....	Fresh leaves used in tomato pastes; demand for oil very small; 10 to 15 acres probably sufficient for oil production. Grown and handled somewhat like tobacco; a profitable crop during the world wars; requires special facilities for drying.
Boneset.....	None.....	Central and Eastern States in areas where it grows wild.	1,000-2,000.....		
Burdock.....	Occasional when price is high.	Eastern and Central States.	1,500-2,000.....		Harvesting the roots sometimes difficult and expensive. Requires much hand labor in harvesting.
Calendula.....	None.....	Northern States.....			Harvesting the flowers by hand or with box strippers requires much hand labor.
Camomile (German, or Hungarian, and Roman). Caraway.....	do..... Limited; in California in some years.	Most Northern States..... Northern Pacific coast; in Southwest possibly as winter crop.	300-500..... Seed, 800-1,200.....	350..... Seed, 6,000; oil, 240.....	Some varieties produce seed first season; others the second season; cultivated as a truck crop; harvested by cutting, shocking, and threshing or with combine.

Castor-bean.....	Principally in Kansas in the past; occasional elsewhere.	South-central Ohio-Missouri; Mississippi Valley, Kansas, Oklahoma, Texas, southern California, Arizona.	800-1,000.....	175,000.....	Practical harvester and more efficient seed huller needed for large-scale growing; several varieties adapted to the sections mentioned have been developed.
Catnip.....	None.....	Most sections.....	1,500-2,000.....	1,000-5,000.....	Grown from seedling transplants; includes pungent varieties only, not the mild paprika type.
Cayenne.....	Southwest; southern Louisiana and Mississippi; South Carolina. Very little, for condiment use.	Southern Coastal Plain and Gulf coast; Southwestern States. California and Southwestern irrigated valleys.	300-1,000.....	3,500.....	Can be grown much like sugar beet seed crop; no seed obtained the first year.
Celery.....	By bulb growers mainly for nursery trade.	Most areas where bulbs are grown.	300-600.....	.....	The species used in the drug trade can probably be grown to best advantage by commercial bulb growers.
Coleicum.....	None.....	Adapted to wide range of conditions.	Seed, 500-800.....	4,500.....	Cultivated as a truck crop; harvested and threshed as small grains; may have possibilities as a winter crop under irrigation in the Southwest.
Coriander.....	do.....	Gulf coast, Pacific coast.....	400-600.....	1,800.....	Cultivated as a truck crop; harvested and threshed as small grains.
Cumin.....	do.....	Wherever it grows wild.....	1,000-1,500.....	75.....	A persistent weed. Cultivated somewhat like tobacco; generally harvested and dried like belladonna; profitable under favorable conditions, but overproduction easily possible.
Dandelion.....	Some by pharmaceutical manufacturers; collected from wild plants in Pacific Northwest.	North Central and Pacific Coast States.	Herb, 500-700; oil, 15-30.....	.....	Generally grown for herb and oil under contract with manufacturers of food products.
Digitalis.....	Small acreage for herb and oil in North Central States and for oil in Oregon.	Middle West.....	1,500-2,500.....	Seed, 425.....	Roots do not reach marketable size in less than 3 or 4 years. Requires 2 years to make a crop. Cultivated as a perennial truck crop; harvested and threshed as small grains.
Dill.....	None.....	Northern States.....	600-800.....	.....	Requires shade and several years to develop a root crop; not promising.
Echinacea.....	do.....	Mountain sections.....	1,000-1,500.....	800.....	Digging, cleaning, peeling, and drying of rhizomes requires much labor.
Elecampane.....	do.....	Subtropical Florida.....	1,500-3,000.....	.....	Must be grown in shade; roots require 5 to 7 years to reach marketable size; subject to serious diseases and damage by mice.
Fennel.....	do.....	Only in regions where now grown.	.....	.....
Gentian.....	do.....				
Ginger.....	do.....				
Ginseng.....	In small plots in Northern and North Pacific Coast States.				

See footnotes at end of table.

TABLE 2.—Summary of agricultural information on medicinal and condiment plants that are or can be grown in the United States—Continued

Plant	Agricultural information				Remarks on handling and commercial possibilities
	Domestic production	Areas possibly suitable for commercial production	Probable acre yield of marketable product ¹	Estimated area required to produce the average quantity imported ²	
			<i>Pounds</i>	<i>Acres</i>	
Goldenseal.....	In small plots in Northern and North Pacific Coast States.	Only in regions where now grown.	1,200-2,500.....	.....	Must be grown in shade; 4 to 5 years required to produce crop of roots from seed; subject to several serious diseases.
Henbane.....	Small acreage when price is high; collected wild on Great Plains.	Northern and Western States.	500-700.....	175.....	Cultivated, harvested, and dried like belladonna; very susceptible to a destructive virus disease.
Horehound.....	None.....	Northern and West Coast States.	1,500-2,000.....	.....	.....
Larkspur.....	On commercial scale in California during World War II.	Over wide areas.....	200.....	.....	Has produced well in the flower-seed section of Santa Barbara County, Calif.
Lavender.....	Small planting in western Washington.	Pacific coast, mild regions with limited summer rainfall.	Flowers, 300-600; oil, 12-15.	.....	A mechanical harvesting method is needed to reduce labor cost; grows slowly in early stage, making weed control costly.
Licorice.....	None.....	California; Southwest.....	5,000.....	13,400.....	Indicated yield obtained after 3 years; acreage shown is that which must be harvested each year.
Lobelia.....	.....do.....	Eastern States.....	Herb, 800-1,200.....	.....	Propagation from seed; information on culture lacking.
Lovage.....	.....do.....	Eastern and Midwestern States.	Roots, 800-1,200.....	.....	Yield indicated is from a 3-year crop.
Marjoram.....	.....do.....	Northern and West Coast States.	1,500-2,000.....	75.....	Can be grown as an annual where it does not survive the winter, but requires much hand labor in harvesting.
Melissa.....	.....do.....	Eastern and West Coast States.	Leaves, 800-1,000.....	.....	.....
Mustard.....	Up to 100,000 acres, mostly in Montana.	West coast, northern Mountain, and Plains States.	400-1,000.....	.....	Domestic production during several of the war years greatly exceeded the requirements.
Orris.....	None.....	Regions adapted to ornamental iris culture.	10,000-12,000.....	.....	Indicated yield is from a 3-year old crop; roots must be peeled by hand; only a few species are suitable, and unless conditions are entirely favorable the roots lack fragrance.

Paprika.....	Principally in California and South Carolina.	Southeastern and Southern States; irrigated sections of Southwest.	800-1,000.	5,500.	Grown by transplanting seedlings like sweet peppers and tomatoes; special drying equipment needed for large-scale production; use of fully nonpungent varieties most important.
Parsley.....	None.....	Vegetable seed-growing regions.	.....	.....	.....
Pennyroyal.....	do.....	Mountain sections of Eastern States.	Herb, 1,000-1,200; oil, 10-15.	.....	.....
Peppermint.....	Michigan, Indiana, Oregon, Washington, California.	Muck soils in the Northern and Pacific Coast States.	Oil, 20-40.	.....	About 47,000 acres in 1947, of which 70 percent was in Midwest; grown mainly on muck land; production adequate to meet domestic requirements.
Pinkroot.....	None.....	Eastern and Southern States.	400-500.	.....	Indicated yield from a 4-year crop; the use of the root is declining rapidly.
Pokeroot.....	None.....	Eastern States.....	Roots, 500-600; fruit, 200.	.....	Indicated yield of roots is obtained in first year; thereafter the yield is several times as large; indicated fruit yield is that of the second and subsequent years.
Sage.....	Small acreage in Wisconsin, Tennessee, and elsewhere.	Central and Eastern States.	1,500-2,000.	1,500.	Grown from seed or cuttings as perennial; harvesting the leaves only requires too much hand labor; tops are cut and dried and large stems then separated.
Senega.....	Small plots occasionally in Northeast.	Northeastern States.....	.....	.....	4 years required to produce a marketable root; no estimates of yield available.
Sesame.....	None.....	Warm sections; mainly cotton areas of South and Southwest.	700-1,500.	For seed, 10,000; for oil, 12,000.	Grown from seed planted in rows; seed shatters when mature; plant subject to disease.
Spear-mint.....	Michigan and Indiana.....	Northern and Pacific Coast States, preferably on muck soil.	Oil, 25-40.	.....	Adapted to same regions and handled in same way as peppermint; 14,300 acres in 1947; production ample for domestic requirements.
Stramonium.....	None.....	Practically wherever the plant grows wild.	Leaves, 1,000-1,500; seed, 500-2,000.	250.	Seed sown directly in field; grows wild in many places; import figures probably refer to leaf only and acreage required is calculated on that basis; formerly cultivated in California.
Tansy.....	Michigan and Indiana.....	Muck soils in North Central States.	Herb, 1,800-2,000; oil, 10-40.	.....	Crop best grown by mint growers who have facilities for distilling the oil; very limited market for herb and oil.

See footnotes at end of table.

TABLE 2.—*Summary of agricultural information on medicinal and condiment plants that are or can be grown in the United States—Continued*

Plant	Agricultural information				Remarks on handling and commercial possibilities
	Domestic production	Areas possibly suitable for commercial production	Probable acre yield of marketable product ¹	Estimated area required to produce the average quantity imported ²	
Tarragon.....	None.....	Mild sections.....	Pounds.....	Acre.....	
Thyme.....	do.....	Mildest sections of Northern and Pacific Coast States.	Herb, 1,000-2,000; oil, 20.	Herb, 150.	Domestic possibilities unknown; could probably be grown as companion crop to wormwood and mint.
Valerian.....	Occasionally in New England and New York.	Northeastern States.....	Roots, 1,800-2,200.		Grown from seed or cuttings; probably no crop the first year; considerable hand labor required in harvesting.
Vetiver.....	Small acreage in southeastern Louisiana.	Gulf coast; Florida.....	Roots, 1,800-2,000.		
Wintergreen.....	None.....	Mountain sections of New England and Middle Atlantic States.			Use of root restricted largely to locality where now grown; oil very difficult to distill.
Wormseed (American).....	Central Maryland.....	Eastern States.....	Seed, 1,000; oil, 20-40		Plant grows slowly, yield of herb and oil believed small.
Wormwood.....	Michigan and Oregon.....	North Central and North Pacific Coast States.	Herb, 1,000-2,000; oil, 10-40.		Crop grown exclusively in central Maryland for over 100 years; could be grown in most of the Eastern States; easily overproduced; present acreage entirely adequate.
					Present acreage in Michigan and Oregon mostly grown for oil under contract; adequate for domestic requirements

¹ If more than one product can be obtained, information concerning all is given if available.

² 1936-38 or during the period indicated in column 3 of table 1.

normal prices prevailed. Comparisons of that year with 1933 show the trend during that 5-year period.

During the war and in the immediate postwar period the values were very much higher, but to list them would be misleading because such high levels are not likely to prevail after the agricultural and general economic conditions in foreign countries return to normal and prewar world trade relations are restored.

The prices shown are quoted⁷ by dealers and wholesalers to buyers on the New York market and are much higher than the grower would receive. This fact must not be overlooked. The figures serve, nevertheless, to indicate relative values and are therefore of interest to the prospective grower. Before he decides to grow any of these crops he should ascertain current market demands and values from buyers, consumers, or other reliable sources.

The agricultural information in table 2 is intended only to indicate where, if anywhere in the United States, these crops are now grown; to what regions they are probably best adapted; what yields may be expected; and how much acreage is needed to supply the demand. For some plants too little is known regarding commercial production to make such information available.

Aconite

Aconite (*Aconitum napellus*) (fig. 4) is a hardy herbaceous perennial native to the mountainous regions of central Europe. The value of the root, the part most used in medicine, depends on the presence of the alkaloid aconitine. The leaves also are used, but to a minor extent. Several subspecies and varieties that contain this alkaloid also are acceptable for medicinal use. This species is grown more or less as an ornamental in this country, but has not been cultivated as a source of the root for drug purposes. The quantity used is relatively small.

The plant appears to thrive best in a cool climate in a well-drained gravelly loam in elevated situations, but it can be grown in any rich garden soil. Seed can be sown in the open late in the fall or early in spring, or plants can be started in a seedbed and the seedlings later transplanted and set about 1 foot apart in rows spaced 2 feet apart. Propagation by division of the roots after the stems have died down in fall is a better method because it is difficult to obtain seed that produces plants true to type. In the northern and central sections of the country the plant requires some protection in winter.

The roots should not be harvested until the plants have flowered and the stems have died down in fall, when all the roots should be dug. The small roots may be reserved advantageously for planting and the large ones washed, sliced lengthwise, and dried. Those propagated by root division in fall will flower the following season, but seedlings usually do not flower until the second year. The leaves may be harvested earlier in the season if there is a demand for them.

No reliable data on yields are available, but it is estimated that 400 to 500 pounds of dry roots per acre can be expected. If the plants are grown from seed this yield represents the returns from 2 years' use of the land. Attempts to grow this crop in this country have generally not been successful.

⁷ Taken from the Oil Plant and Drug Reporter, a weekly trade paper.



FIGURE 4.—Aconite.

Althea

Althea, or marshmallow (*Althaea officinalis*) (fig. 5), a perennial herb introduced from Europe, now grows wild in marshy places near the sea in Massachusetts and Connecticut and along tidal rivers in New York and Pennsylvania. The root is the official drug, but the leaves and flowers also are sometimes used medicinally.

The plant grows well in almost any loose garden soil of moderate fertility but tends to winterkill under cultivation in situations where the ground freezes to a considerable depth and no mulch or other protection is provided. The plants can be propagated from seed or from divi-

sions of the old roots made early in spring. The seed is sown in shallow drills at least 3 feet apart, and the seedlings thinned to stand 12 inches apart in the row. Under good conditions the plants attain a height of 3 or 4 feet. The roots are harvested the second year, washed, peeled,



FIGURE 5.—Althea.

cut into short lengths, and thoroughly dried. Yields of dry root at the rate of 800 to 1,000 pounds per acre have been obtained. In view of the rather limited demand for the root, the hand labor required in preparing it, and its relatively low price, the cultivation of this plant is not likely to be profitable.

Angelica

Angelica (*Angelica archangelica*) (fig. 6) is a European biennial plant sometimes grown in this country as a culinary herb and known commonly



FIGURE 6.—Angelica.

as garden angelica. The fresh stems and leafstalks are used as a garnish and for making a candied confection. The seeds and the oil distilled from them are employed in flavoring, and the aromatic roots are sometimes used in medicine.

The plant thrives best in a moderately cool climate and may be grown in any good soil, but a deep and fairly rich moist but well-drained loam well prepared before planting will give the best results. The plant is most readily propagated from division of old roots, which can be set either in fall or in spring about 18 inches apart in rows. The seed germinates very poorly if more than 1 year old, and it is best to sow it as soon as it is ripe in a seedbed that is kept moist. Early the following spring the seedlings are transplanted and set in their permanent location about 18 inches apart in rows spaced 3 feet apart. Plants may also be obtained from seed sown in March in a spent hotbed or in a coldframe. In order to increase root development, the plants are often transplanted a second time, at the end of the first year's growth, and set 3 or 4 feet apart. For the same reason the tops are often cut back to prevent the formation of seed. During the growing season the soil should be kept mellow and free from weeds by frequent cultivation.

Sometimes the roots of first-year plants are dug, but usually the harvest is deferred until the fall of the second year. The roots are washed and dried in the open air. Estimates of yields are not available. It is best to store the dried root in tin containers that can be tightly closed to keep out insects and to preserve the aroma.

Roots collected from wild plants of a native species, commonly called American angelica (*A. atropurpurea*), also are handled in the drug markets of this country, but they bring a much lower price.

Anise

Anise (*Pimpinella anisum*) (fig. 7), an annual herb, has been widely cultivated throughout the world. The dried fruits, which are usually called seeds, have been for centuries used for flavoring pastries, candies, and beverages. The oil distilled from the seed is frequently preferred for flavoring and has gained favor in this use because the seed has an undesirable appearance in some edible products. The oil is also used in medicines, perfumery, soaps, and other toilet articles.

The plant requires a light, fertile, sandy loam that is well drained and can be so pulverized that the small seed can be planted at a uniform depth and the very small young seedlings cultivated. A frost-free season of at least 120 days is required, and uniform rainfall throughout the growing season is essential because the plant is unfavorably affected by sudden changes from wet to dry periods. The temperature throughout the growing season should be fairly uniform without excessively hot periods, especially following rainfall. When the seed is near maturity alternate rainy and dry periods cause it to become brown, which greatly reduces its quality, and under such conditions the harvesting of the seed is difficult.

The seed is planted about $\frac{1}{2}$ inch deep in the field in rows 18 to 30 inches apart at the rate of one to two seeds per inch. At this rate about 5 to 10 pounds of seed are required to plant 1 acre. Growers in some European countries broadcast the seed, but as a rule weeds are a major difficulty and if these are present at harvest they are likely to



FIGURE 7.—Anise.

affect the market value of both the seed and the oil. If it is necessary to broadcast the seed and cultivation is therefore impossible it is important that the land be fallowed and in clean culture the previous season. The harvesting of anise presents some difficulties in that the umbels ripen progressively and the seed ripens unevenly within each umbel.

In countries where the plants are grown commercially they are either pulled out of the ground or the tops are cut off by hand. The material thus obtained is tied in bundles and then stacked in a conical pile with the fruiting heads toward the center. This is usually done when all the seed of the umbel is still green. The seed then continues to ripen and when mature does not discolor and shatter from the plant. In foreign countries the seed is usually flailed out, but it can doubtless be threshed by machinery. After the threshed seed is cleaned it is bagged for the market. The oil is extracted from the seed by steam distillation. Under favorable conditions a seed yield of 400 to 600 pounds per acre can be expected.

The climatic and soil conditions of the Central and Eastern States offer some possibilities for anise production, but the rainy weather that may occur there when the seed should be harvested may reduce the yield

and quality. Some irrigated sections in California and elsewhere in the West can perhaps be utilized for this crop if the temperatures are not too high during the growing and maturing season. The plant also has possibilities as a winter crop in the irrigated valleys of the Southwestern States, where it must be planted late in September or early in October.

Arnica

Arnica (*Arnica montana*) is a herbaceous perennial plant native to northern and central Europe, where it thrives in the cool climate of mountain meadows. The flowers, leaves, and roots are employed in medicine.

The plant requires a cool climate for best development. It is propagated by divisions of the roots or from seed sown in the field either in fall or in spring. Seed may also be sown in August in a seedbed and the seedlings transplanted the following spring. In the field the plants should stand about 18 inches apart in the row. The flowers are harvested the second year and the roots after 3 or 4 years.

Arnica is not produced commercially in the United States. The small quantities of the used parts imported annually are apparently sufficient to meet the market demands. Its cultivation presents many difficulties. Attempts to grow the plant in this country have been made in regions to which it is not adapted and therefore have generally proved unsuccessful.

Basil

Basil (*Ocimum basilicum*) (fig. 8), an annual spicy herb, has long been grown in gardens for culinary use and is cultivated in southwestern Europe for the production of its volatile oil, which is used as a flavoring agent and in perfumery.

The plant is adapted to any conditions favorable for vegetable crops. It is grown readily from seed, which can be planted in spring with a vegetable seed drill in well-prepared ground in rows 2 to 3 feet apart. The seed should be dropped at a rate that will assure 6 to 12 plants per foot, which requires about 5 pounds of good seed per acre. Control of weeds is important, because their presence in the harvested crop reduces its flavoring quality and the value of the oil.

The crop is harvested in the blooming stage with a scythe or hay mower. If intended for oil production it is left in the swath long enough to dry partially and is then distilled with steam like other volatile-oil crops. If the leaves are to be marketed the herb should preferably be dried under cover to preserve the green color. In some seasons the crop can be harvested twice, but the second yield is usually small. No figures on the yield of oil from commercial fields are available, but experimental plantings have indicated that it may range from 20 to 40 pounds an acre.

Although the oil possesses the same fragrance as the leaves, its use in this country is extremely limited and only a few acres would be sufficient to meet the present requirements. Unless the market demand increases greatly, basil could best be grown as an oil crop by a few persons who are producing other volatile oils.



FIGURE 8.—Basil.

Belladonna

Belladonna (*Atropa belladonna*) (fig. 9) is a perennial herb with important medicinal properties, which are due to the poisonous alkaloids present in all parts of the plant. The dried herb (leaves, flowers, and small stems) and the roots are used in the preparation of a number of important medicines.

The plant thrives best in a deep and moist but well-drained loam such as will produce a good crop of vegetables. It will not survive long in situations where subsoil drainage is poor. Cultivation has been

successful in the Northeastern and North Central States and under irrigation in the Los Angeles and Bay regions of California and in eastern Washington, which indicates that these are favorable regions for this crop.

Commercially belladonna is usually propagated from seed, although new fields can be planted with divisions of the fleshy rootstocks of old plants. Individual seeds vary greatly in the time required for germination. It therefore sometimes takes 4 to 5 weeks to obtain a good stand of seedlings from a given lot of seed. About 1 ounce of seed will provide enough plants for 1 acre.

The seed is sown thickly in pots or well-drained boxes in late winter in a cool greenhouse, a coldframe, or outdoor seedbed early in spring, as in the case of tobacco. When the seedlings grown indoors are large enough to handle they should be transplanted to light rich soil in small individual pots or seed flats in the same way as tomato or other vegetable plants intended for field planting. As soon as danger of frost is over they should be transplanted to a deeply plowed and well-prepared field by hand or with transplanting machines and set about 20 inches apart in rows 30 inches or more apart.

Sowing seed in the field seldom gives good results. Greenhouse propagation of the seedlings is relatively expensive, but this practice is recommended when the drug has a high market value. A much larger crop is generally obtained because the seedlings are ready to be set in the field earlier. Hand cultivation is necessary to control weeds while the plants are small, but later light cultivation can be done with a field cultivator.

In most localities it is necessary to use insecticide dusts or sprays on belladonna plants of all ages as protection against the flea beetle,



FIGURE 9.—Belladonna.

the common potato beetle, and other insects. Cutworms also may cause loss of young plants. Under some conditions many plants are killed after midsummer by stalk borers. There is no practical means of controlling this insect.

When the plants are set in the field late and growing conditions early in summer are unfavorable only one crop of herb can be harvested the first season. If large and vigorous seedlings are set early enough, however, the plants can sometimes be harvested several times and the yield of the herb thus greatly increased. In many localities the plants frequently do not survive the winter, especially if they are cut late in the season. It has therefore been generally found best to harvest all the herb possible and also the roots the first year and start a new planting the next year.

The herb, consisting of leaves, flowers, and small stems, is harvested when the plants are blooming. It must be carefully handled and dried in the shade in order to retain its green color. Small quantities of such material sometimes dry satisfactorily if spread thinly on clean wooden floors and stirred frequently or if hung up in small bunches in tobacco barns or similar structures, but weather conditions will largely determine the success of these practices. The use of gentle heat from a stove or furnace in a building designed for this or similar purposes is necessary for handling large quantities rapidly. The roots are thoroughly cleaned and cut into short lengths, the thick portions being split lengthwise and dried thoroughly in the sun or with mild artificial heat.

In favorable localities in the United States dried herb yields of considerably more than 1,000 pounds per acre have been obtained in a season, but on the average 600 pounds can be expected. The yield of roots is 150 to 300 pounds per acre.

During the two world wars, when belladonna could not be obtained from Europe, this crop was profitably grown in many sections of this country. In 1942 more than 500 acres of the herb were planted in Pennsylvania, Wisconsin, California, Ohio, Tennessee, Kentucky, Virginia, and several other States, with a production estimated at more than 400,000 pounds. On the whole the crop was much more successful in the first three States mentioned than in the others.⁸

Boneset

Boneset (*Eupatorium perfoliatum*) (fig. 10) is a rather long-lived hardy perennial plant commonly found in low grounds throughout the eastern half of the United States. The dried leaves and flowering tops are used in medicine.

Divisions of clumps of wild plants collected early in fall will serve best for propagation. These are set about 1 foot apart in rows in well-prepared soil. During the first winter the newly set divisions are protected with a light mulch of straw or manure. Plants can also be grown from seed, collected as soon as ripe, and sown in shallow drills about 8 inches apart in a moist, rich seedbed, preferably in partial shade. When of sufficient size the seedlings are set in the field spaced about the same as the divided clumps.

The plants are cut when in full bloom late in summer, and the leaves and flowering tops are stripped from the stems by hand and carefully

⁸ Complete information on this crop is available in a processed leaflet, DRP 22, Belladonna as a Domestic Crop (10 pp.), issued by this Bureau.



FIGURE 10.—Boneset.

dried without exposure to the sun. Yields of 2,000 pounds or more per acre of the leaves and tops of cultivated boneset can be obtained under favorable conditions. Since the demand is limited and the wild plant fairly available, the cultivation of boneset does not offer much prospect of profit.

Burdock

Two species of burdock (*Arctium lappa* and *A. minus*) (fig. 11) are large biennial plants well known as common and troublesome weeds

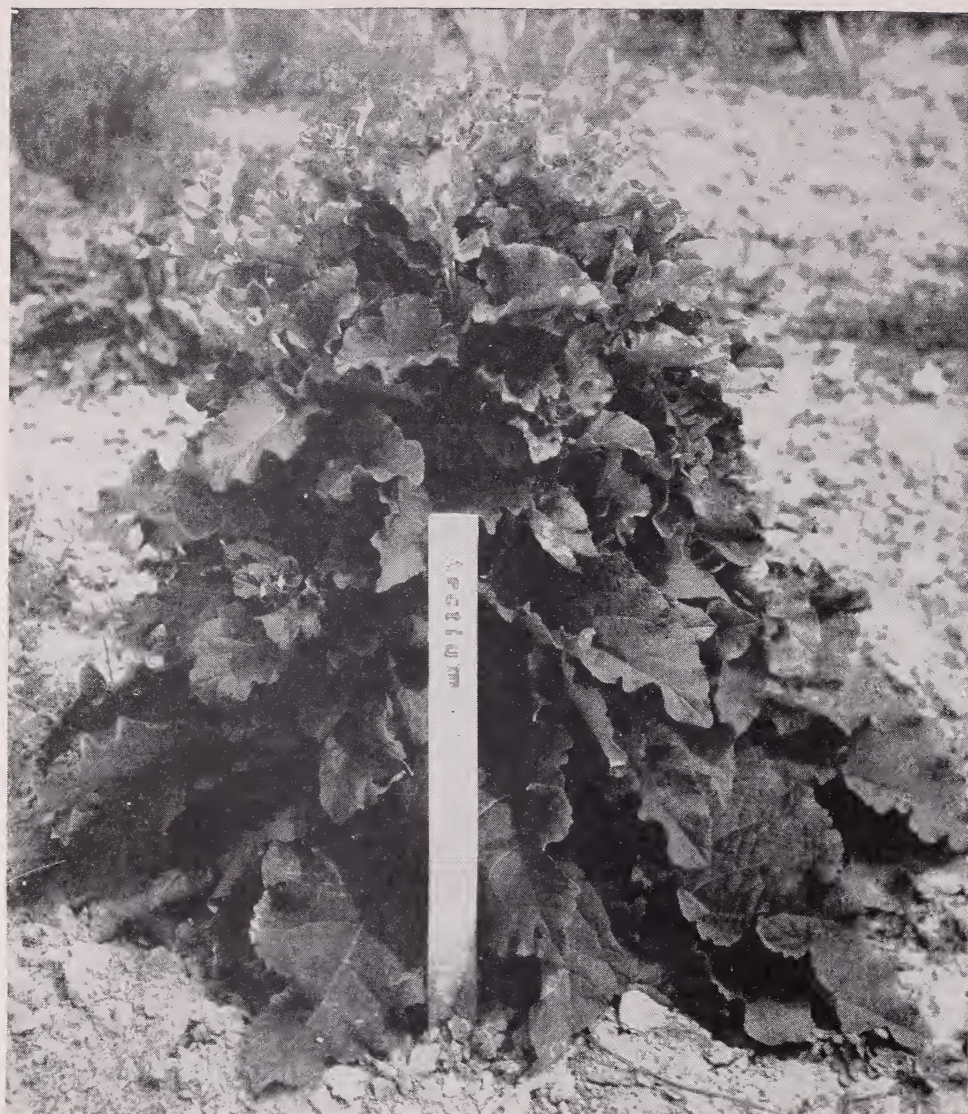


FIGURE 11.—Burdock.

in the Eastern, Central, and some Western States. The dried root from these plants of the first year's growth and the seed are used medicinally.

Burdock will grow in almost any soil, but the best root development is favored by a light well-drained soil rich in humus. The seed germinates readily and can be sown with a small seed drill directly in the field in rows 18 inches to 3 feet apart either late in fall or early in spring. When well up in spring the seedlings are thinned to stand about 6 inches apart in the row. Cultivation is continued until the plants get too large.

The roots are harvested at the end of the first year's growth, in order to obtain the most acceptable drug and to prevent the plants from bearing seed and spreading as a weed. The tops of the plants can be cut with a mower and raked off, after which the roots can usually be turned out with a deep-running plow or with a beet lifter. In a dry and very sandy soil the roots frequently extend to such depth that it is necessary to dig them by hand. After digging, the crowns are removed

and the roots washed and then dried, preferably by the use of low artificial heat. To facilitate drying they are usually split lengthwise into two or more pieces. Yields of dry roots at the rate of 1,500 to 2,000 pounds per acre have been obtained.

Calendula

Calendula, or pot marigold (*Calendula officinalis*) (fig. 12), a hardy annual plant native to southern Europe, is frequently grown in flower gardens in the United States. The dried flower heads are sometimes



FIGURE 12.—Calendula.

used in soups and stews, and the so-called petals (ligulate florets) constitute the drug used in medicine.

Calendula grows well on a variety of soils, but a moderately rich garden loam will give best results. The seed, which germinates rapidly, is sown in open ground early in spring in drills 18 inches apart. As soon as the seedlings are established they are thinned to stand about 1 foot apart in the row.

The plants blossom early and continue to bloom throughout the summer. The flowers are gathered at intervals of a few days and carefully dried. The ligulate florets can be removed either before or after the flower heads are dried. This must be done by hand, but it requires so much time that it is doubtful whether the drug can be produced at a profit in this country. No information on yields is available.

Camomile (German, or Hungarian)

German, or Hungarian, camomile (*Matricaria chamomilla*) (fig. 13) is a European annual herb cultivated in this country in gardens, from which it has escaped in some localities. The dried flower heads are used in medicine.

This species does well on moderately heavy, rather moist, soil rich in humus. Since the plants bloom about 8 weeks after the seed is sown, a crop can be grown from seed sown either early in spring or late in summer, following early vegetable crops. Seed sown early in fall will give a good stand of plants that will produce a crop of flowers the next spring. The seed can be sown in drills and barely covered or broadcast, since the plants will soon occupy the ground and exclude the weeds.

When the plants are in full bloom the flower heads are gathered and spread thinly on canvas sheets and dried in the sun. As hand picking is extremely tedious the use of some kind of box stripper is recommended. Even with such devices the cost of harvesting is excessive unless labor is very cheap.



FIGURE 13.—Camomile (German, or Hungarian).

The dried flowers should not be marketed in bags but in boxes or bales because the trade prefers them in unbroken condition. Returns from experimental areas indicate that dry-flower yields of about 400 pounds per acre can be expected under favorable conditions. The cost of hand labor would probably make commercial production of this crop unprofitable in this country.

Camomile (Roman, or English)

Roman camomile (*Anthemis nobilis*) (fig. 14), also called English camomile, is a European perennial herb frequently cultivated in gardens in this country and sometimes found growing wild. In America it is

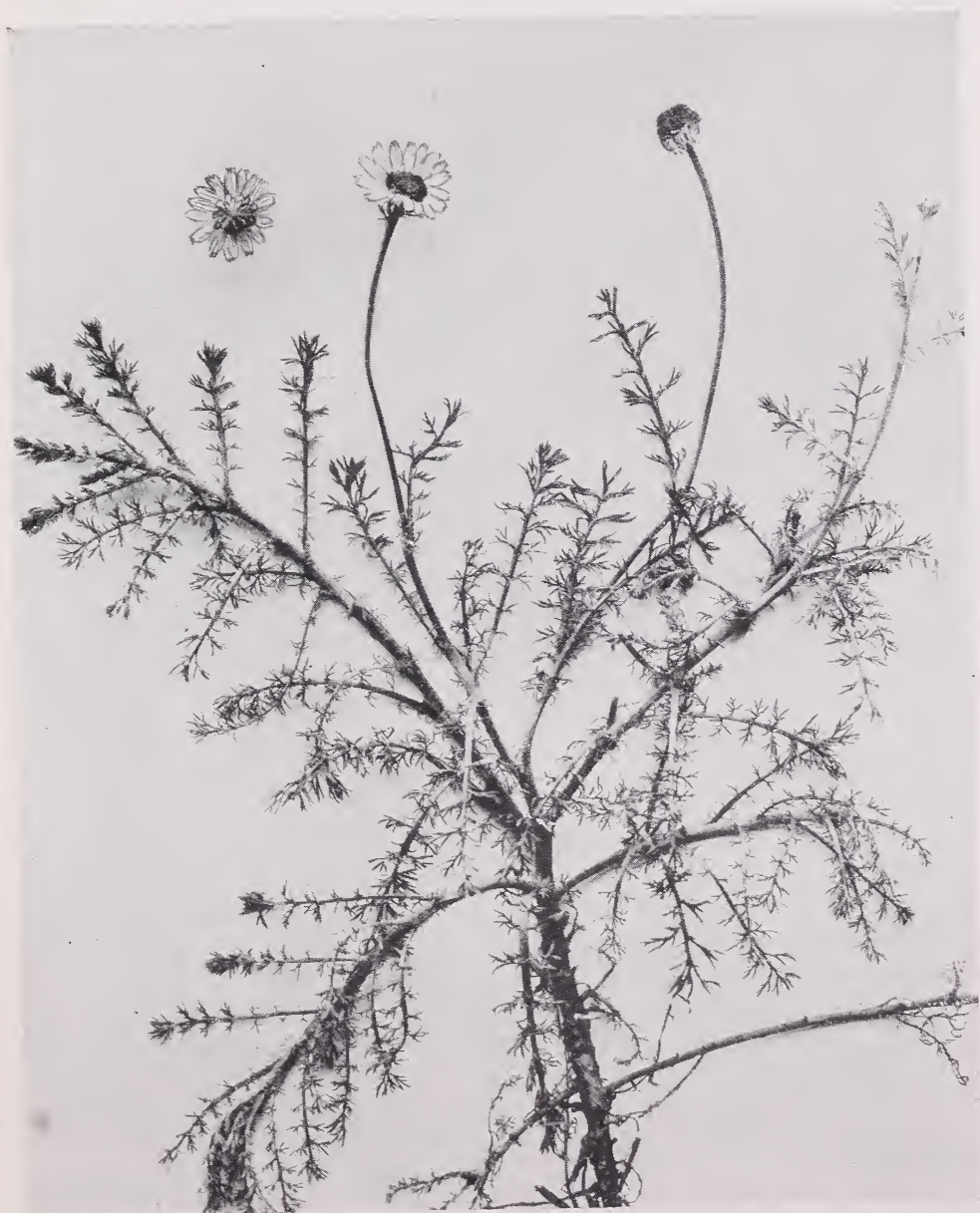


FIGURE 14.—Camomile (Roman, or English).

grown chiefly as an ornamental plant, especially for use in borders, since the plants blossom from midsummer until killed by frost. The dried flower heads from cultivated plants are used in medicine.

This species grows well in almost any good, rather dry soil in sunny locations. The plants may be grown from seed or propagated by root divisions early in spring. The divisions are planted 9 inches apart in rows spaced according to the method of cultivation to be used. Hand weeding is necessary, but since the plants soon spread and fully shade the ground, weeds usually are not troublesome.

The flower heads are gathered just as they open, either by hand or by means of a box stripper, and are dried in the open in bright weather or, when necessary, on canvas trays in a heated room. Rapid drying is essential, as it is desirable to retain the natural color as far as possible. From 400 to 600 pounds of dried flowers per acre may be expected. Unless a mechanical method of harvesting is devised, this crop, like the German camomile, is not likely to be profitable, owing to the hand labor required.

Caraway

Caraway (*Carum carvi*) (fig. 15) is an annual or a biennial herb that has been cultivated in many parts of the world for flavoring purposes. The dried fruits, which are known commercially as seed, are used in bakery products and also to flavor cheese and confections. The oil distilled from the seed is used for certain medicinal purposes and in the manufacture of liqueurs.

The plant grows in a wide range of soil conditions, but probably does best on an upland fertile clay. As cultivated in Europe it is usually a hardy biennial that withstands a rather severe continental climate and matures seed early in the second season. The plant is best adapted to the cool climate of temperate regions. When selecting suitable locations for this crop consideration should be given to possible damage from heavy rains and severe winds at harvesttime. Caraway has been grown in many parts of the United States but not on a commercial scale until World War II, when an annual variety was under cultivation in California and a biennial variety in Idaho.

When grown as a biennial the seeds are usually drilled early in spring about $\frac{1}{2}$ inch deep in rows 16 inches apart at the rate of 6 to 8 pounds to the acre. Light but frequent cultivation to control the weeds is necessary and in weedy soil hand weeding also may be required. If sown broadcast or in rows too close for cultivation the adequate control of weeds would probably be impossible. In foreign countries when the biennial variety is grown it is common practice to plant some early annual vegetable crop between the rows of the slow-growing caraway. By this means some return is obtained from the land the first season. The biennial caraway crop is harvested in June of the second year.

In California, where the annual variety has been grown, the seed is sown early in spring and the crop matures late in summer. When the first seeds are mature caraway should be cut with some mowing machine that will deposit the cut material in windrows in which it is allowed to cure to some extent. Several methods of handling are used, depending on the size of the crop, the weather conditions, and the implements available at the time.



FIGURE 15.—Caraway.

After partial drying in the windrow the herb may be moved indoors to complete drying or it may be placed in shocks or piled on large pieces of canvas in the field. As the seed comes to final maturity in the curing process, shattering is likely to be excessive unless the crop is handled carefully. For this reason curing on canvas or in barns or open sheds where the shattered seed can be collected has a definite advantage. Seed that does not shatter from the plant after the drying process can easily be removed by flailing or with a grain thresher. In some sections of the Pacific Coast States and adjoining Mountain States where dry clear weather prevails when the caraway matures, the crop has been

allowed to ripen thoroughly in windrows and it is then harvested with a combine with a special attachment for elevating the material into it with a minimum loss of seed.

According to limited experience with the crop in Idaho, a yield of 700 to 1,200 pounds of seed may be expected when the biennial variety is grown. This cannot be figured as an annual yield, because a planting made early in spring would not yield a crop until the second summer. In California the annual variety has produced on the average about 700 pounds. From 4 to 6 pounds of oil may be obtained from 100 pounds of seed.

Castor-bean

The castor-oil plant (*Ricinus communis*) (fig. 16) is a robust perennial in tropical countries, but in regions subject to frost it is grown as an annual. The seeds of this plant, called castor-beans, yield the castor oil of commerce, which has long been used medicinally but is a much more important commodity in the manufacture of many technical products. Between 1860 and 1900 the castor-bean was an important crop in the Middle West, particularly in sections of Kansas and Oklahoma, but the quantity of the beans produced was never large and the castor oil



FIGURE 16.—Castor-bean.

industry has always depended mainly on imports from various tropical countries.

The need for castor oil as a lubricant in certain types of airplane motors in use during the first world war led to a large-scale planting of the crop in 1918 in the Southeast and South and in California. The results on the whole were discouraging. No acreage was planted thereafter until shortly before the second world war, when interest in the crop was renewed. This was due to a larger demand for the oil, which was being obtained entirely from beans imported mainly from Brazil. During the second world war many experimental plantings were made and some small commercial acreages were planted. These furnished much valuable information regarding the regions in this country where this crop can be grown most successfully and the varieties best suited to each. Most varieties fail to mature in some seasons in regions north of central Illinois. In the Gulf Coast region the crop is frequently damaged by gray mold, a disease that destroys the fruiting spikes. According to all available information the best region for growing castor-beans includes northern Texas, Oklahoma, Arkansas, southeastern Kansas, Missouri, southern parts of Illinois, Indiana, and Ohio, Kentucky, Tennessee, and northern Mississippi. Some areas in southeastern Texas and southern California are also believed to be suitable.

The crop is adapted to corn or cotton land, which should be prepared as for these crops. Corn planters with certain modifications can be used in seeding. The spacing of rows and of plants within the rows may be such as to permit the use of available planting and cultivating equipment. The seed should be planted $1\frac{1}{2}$ to 3 inches deep, depending on the moisture in the soil. From 7 to 10 pounds of seed are required to plant an acre, depending on the variety. Weeds must be kept under control by frequent shallow cultivation early in the season.

The beans are borne on large spikes that form and develop during the warm weather late in summer and early in fall. Not all the beans on a spike mature at the same time. Although progress is being made in devising a harvester, the lack of a practical and economical machine for this purpose is one of the principal obstacles to castor-bean production in this country. An improvised harvesting scoop modeled after a grass-seed stripper or cranberry scoop has been designed and used with limited success for stripping pods from the spikes. This scoop, a cylindrical metal container, holds about 2 quarts and has a V-shaped notch in the side opposite the handle.

In using the stripper the base of the spike below the pods is caught in the notch, and by moving the scoop upward the pods are stripped into the scoop, which is then emptied into a picking bag or basket. Some growers cut the spikes from the plant and strip the pods from each spike by pulling it through a V-shaped notch in the side of a collecting box. The central stem of the spike is then discarded in the field. The box, built on runners to keep it low and within easy reach, is pulled between the rows by a horse.

The most economical harvesting method from the standpoint of time and labor required is to strip the dry pods from the plants in the field without cutting off the spike. A worker wearing heavy gloves can strip the dry pods from the spikes and collect them in a cotton or fruit-picking bag or basket. The usual practice is to drive a wagon or sled past the ends of the rows and harvest the field lengthwise along the rows and back to the wagon. By this method one person can harvest

600 to 1,000 or more pounds of beans in the hull per day, depending on the abundance and size of the spikes. Not all the spikes form and develop within a short period, and the beans do not mature uniformly on the spikes; it is usually necessary therefore to go through the field two or three times to obtain the maximum yield, regardless of the method of harvesting used.

If the mature beans in the hull are stripped from the spikes under dry conditions they can be stored in a bin or crib. Several kinds of machines have been designed for removing the beans from the hulls. For efficient machine operation it is necessary that the hulls be entirely dry and the beans of uniform size and shape. Under favorable conditions and with good management the crop may yield 1,000 pounds of shelled beans per acre.

The future of castor-bean growing in this country is uncertain. Castor oil is steadily finding new and wider uses, and a continuing market demand for the beans may be expected. The crop should be grown only in the regions to which it is best adapted, and only pure varieties suitable to the region should be planted.⁹

Catnip

Catnip (*Nepeta cataria*) (fig. 17) is a European perennial plant that frequently occurs in this country as a weed in gardens and about dwellings. It has long had a popular use as a domestic remedy. Both leaves and flowering tops are in some demand in the crude-drug trade.

Catnip does well on almost any good soil, but thrives best on a well-drained and moderately rich garden loam. It will be more fragrant, however, if grown in sandy situations rather than in heavy soils. The plant may be propagated from seed or by root division. The seed is sown in rows either late in fall or early in spring and covered lightly. Fall-sown seed usually gives a more even stand and a heavier growth. When the plants have reached a height of 4 to 5 inches they are thinned to stand 12 to 16 inches apart in the rows. In some localities field sowing does not give good results, in which case plants may be started in a cold-frame and later transplanted to the field. Shallow cultivation will favor vigorous growth.

The flowering tops, harvested when the plants are in full bloom, are dried in the shade to preserve their green color. When larger quantities are grown the herb may be cut with a mowing machine with the cutter bar set high. The plants should lie in the swath until partly dry, and the curing may then be finished either in small cocks in the field or in the barn, care being taken to preserve the natural green color as far as possible.

Returns from experimental areas indicate that a yield of about 2,000 pounds of dried flowering tops per acre may be expected under good conditions. The herb must be carefully sorted and all the large stems removed.

Catnip contains a volatile oil that can be obtained by steam distillation, though the demand for it is limited. It was at one time used as a scent in trapping wild animals of the cat family but has been replaced by a much cheaper synthetic product.

⁹ Full information on the commercial growing of this crop is available in Farmers' Bulletin 2041, Castor Bean Production.



FIGURE 17.—Catnip.

Cayenne

Cayenne and other pungent red peppers used as condiments are obtained as dried fruits from an annual herbaceous plant, *Capsicum frutescens* (*C. annuum*), widely cultivated in many parts of the world and variable in the character of its fruit. They are closely related to the so-called sweet, or mild-flavored, varieties commonly grown in home gardens. The pungent varieties used in the dried form are designated in the trade as dry peppers to distinguish them from the others used in the fresh condition and classed as vegetables. Included among the dry peppers is the paprika, a mild type (see p. 73).

The pungent red peppers as they appear in the trade vary in size, shape, and degree of color and pungency. The pungency is greatest in the tissues near the seed, and the extent to which these tissues are removed determines to some degree the pungency of the finished product. The varieties of pungent peppers are known under various names, such a chili, cayenne, and tabasco. The most pungent types are especially popular as condiments in the warmer regions in this country, particularly among people of Spanish descent.

The pungent peppers require a warm climate and light warm soil. The plants bear fruit throughout the late summer and fall and to produce a full crop must have a long growing season. The plants are propagated from seed planted under glass or in outdoor seedbeds, and the seedlings are set in the field later and cultivated like other truck crops. (For details see Paprika, p. 73.)

In general the pungent peppers are harvested, dried, and cured in the same way as the milder paprika. In the Southeastern and Southern States driers using artificial heat are used in curing large quantities. In the Southwest, small lots can be dried merely by exposing the fruit to the bright sunshine on trays or by suspending it on strings.

The yields obtained from the several varieties vary according to the size of the fruit and other conditions. Considering the group as a whole the yields are estimated to range from 300 to 1,000 pounds per acre.

The annual production of the pungent red peppers in the United States is approximately 1 million pounds, obtained from several thousand acres, principally in California, Louisiana, Mississippi, New Mexico, Arizona, and South Carolina. The commercial production of these varieties in sufficient volume to meet the entire requirement of this country should be entirely feasible by the extension of the acreage in the regions where they are already under cultivation or by their introduction in other areas where conditions are equally favorable. To prevent hybridization it may be necessary to limit production to one variety in a locality, or make certain each year of pure seed from isolated plantings. New growers can benefit much from the fact that the methods of culture and handling are already well understood.

Celery

The celery plant (*Apium graveolens*) (fig. 18), a biennial herb, sometimes an annual, is widely grown in all temperate regions, where it is an important vegetable crop. The dried fruit, commonly called seed, which is the part considered here, is very aromatic and is extensively used for flavoring foods, as a food for birds, and as a source of an essential oil, which also is used for flavoring a variety of products.

Celery may be grown for a seed crop in several ways, depending on climatic conditions. In the Sacramento and Santa Clara Valleys, in California, where most of the seed required for planting is produced, the usual practice is to start the seedlings in summer and transplant them to the field in fall in checkrows about 3 feet apart. The freezing temperatures that sometimes occur in this region apparently do not damage the plants. In spring the plants grow rapidly and by midsummer they produce many flower heads, which mature in August. In the Eastern States, the plants are often grown as an annual by chilling the seedlings in the seedbed early in spring, which causes the plants to produce seed-stalks that season. Another practice is to carry the plants through the winter by protecting them with a heavy mulch against severe freezing. These cultural methods are used in growing celery seed for the vegetable-seed trade, for which higher prices are obtained than could be expected under normal conditions for seed for condiment purposes. For this reason, only a few of the methods of handling described would be practical.

Irrigated valleys in the warmer parts of the Southwestern States may be adapted to celery-seed production. In such regions the seed



FIGURE 18.—Celery.

may be planted late in September or in October direct to beds, as is common there for vegetable crops. The plants mature the following May.

Harvesting can be accomplished by much the same methods as are used for other condiment seed crops. In California, where considerable seed is now produced for the vegetable-seed trade, the plants are cut and laid on long strips of cloth on the ground. After thorough curing the seed is threshed by hauling a roller back and forth over the material. In regions where good drying weather cannot be expected

at all times the crop would have to be stacked in the field and so handled as to reduce the damage from rain to a minimum, or it may be cured under cover. Threshing can also be done with the use of modified grain threshers. The thoroughly dry seed is cleaned with a fanning mill.

The yield of celery seed is apparently not very large and is variable. Producers of the seed for the condiment trade in France report yields ranging from 300 to 600 pounds per acre.

The production of celery seed in this country for the condiment and essential-oil trade would appear to be most feasible in the regions where the seed is already being produced for the vegetable-seed trade, especially in California. The seed that goes into that trade must necessarily be of the best quality. Seed of poorer quality and old seed are now being diverted to use as birdseed. Varieties that may be especially desirable for producing seed for condiment use can no doubt be grown as described where the seed is produced for the vegetable-seed trade. Perhaps the growing of this crop can be so managed as to supply all these markets. No information is available concerning the relative value of domestic-grown seed for condiment use or as a source of the essential oil as compared with imported seed. Geographic source, however, seems to be an important factor in market quotations. It is not likely that domestic production of the seed for condiment purposes would be economically feasible at the low prices quoted in some years, unless it can become a part of the present celery-seed-producing industry.

Colchicum

Colchicum (*Colchicum autumnale*) (fig. 19), commonly called autumn crocus or meadow saffron, is a bulbous plant native to the temperate parts of Europe and northern Africa, where it is found in moist pastures and meadows. The corm (usually called bulb) and the seed contain colchicine, a poisonous alkaloid, used in medicine. In the last 10 years colchicine has also been used in increasing quantities by breeders in developing new varieties and types of plants. Colchicum is grown as an ornamental in this country. The corm and seed used as a source of colchicine have been obtained mainly from abroad.

Colchicum is best adapted to rather moist rich light sandy loam. It will grow in partial shade but can be successfully cultivated in sunny situations. Probably the best practice would be to grow the plant on bulb farms where other flower bulbs are grown. The seed is sown just after it ripens in June or July. The seedlings will not emerge until the following spring and they do not bloom for several years. The plant is also propagated from the corms, which are planted 2 or 3 inches deep late in summer or early in fall. In cold regions some protection in winter is necessary. The new corms are formed from the old ones in much the same way as in tulip bulbs.

The plant blooms in fall, sending short flower stalks directly out of the ground, hence the name autumn crocus. The seed capsule develops underground in the corm and emerges with the leaves in spring. The corms develop their maximum growth during July, after which they can be harvested. They should be dried rapidly by the aid of moderate heat. Spring harvesting, when the seed is mature, presents no special difficulty. *The corms and seed must be handled with much caution, because of their very poisonous nature.*



FIGURE 19.—Colchicum.

Coriander

Coriander (*Coriandrum sativum*), an annual herb, has long been cultivated in many parts of the world. The dried fruits, known commercially as seed, are used for flavoring candies, sauces, soup, beverages, and tobacco products. The oil distilled from the seed also has a variety of uses as a flavor.

The plant is indigenous to southern Europe, Asia Minor, and the southern part of the Union of Soviet Socialist Republics and has been planted in most parts of the world where the climate is suitable. Although

small acreages have been grown in various States from time to time, there has been no sustained commercial production.

Coriander will grow in a wide range of conditions but thrives best in sunny locations on rich garden loam of limestone origin with good drainage. Excessive nitrogen may delay the ripening of the seed and reduce the yield unless the growing season is long. Well-distributed moisture and fairly even temperatures throughout a growing season of 90 to 100 days are favorable for the crop. Rain or wind during the harvest period will discolor the seed and cause loss through shattering. The seed is planted as soon as the soil is warm enough for germination but after danger of frost has passed. It is planted at the rate of 10 to 15 pounds per acre, about 1 inch deep in rows 15 to 30 inches apart. Frequent and light cultivation to keep the weeds under control is recommended, but some hand weeding is usually necessary. Broadcasting the seed is not practical, because coriander does not compete successfully with weeds. Plantings made early in May will usually bloom in about 9 to 10 weeks and mature seed early in August. When grown in the Southwest as a winter crop the seed is sown in November and the crop matures in May.

The ripening of the coriander fruit is progressive, and this causes some difficulty in the harvesting of the crop, which may start when approximately half the total fruits formed have turned gray. Delay would probably lead to excessive shattering of the mature seeds, whereas an earlier harvest would result in loss because some seed would be immature. In order to prevent excessive shattering, the plant is often cut in the early morning when it is damp with dew. Maximum yields could very likely be obtained by pulling the plants and stacking them in a drying barn or in the field with the umbels turned toward the center of the stack. By this method many of the seeds will continue to mature from food reserves in the stalk, and the mature seed will drop to the center of the stack, where it can be collected. Such a method of curing produces a superior quality as well as maximum yield but involves considerable hand labor.

Harvesting with a field mower or binder is reasonably practical when more than small plots are grown. It has been reported that a grain combine has been used with some success in some foreign countries. Because of the loss from shattering and the hazard of unfavorable weather, it is doubtful whether a combine could be used with profit in any part of the United States, except possibly in some favorable irrigated section where no rain occurs during the harvest season. In the Southwestern States the crop could be cut and laid in windrows with the machinery used to harvest flax. After curing in windrows, the threshing can be done with a combine with a pick-up attachment. If storage of the seed is necessary, fumigation is recommended to prevent loss from insect damage.

Experimental plantings in the Southwest indicate that when grown as a winter crop under irrigation in that region coriander may yield 1,000 to 2,000 pounds of seed per acre. Still higher yields have been reported from Europe. These maximum yields could hardly be expected except under ideal conditions for growth and when every effort is made by the use of hand labor to prevent loss of seed by shattering.

From the standpoint of soil conditions required, many parts of the Eastern and Central States are well adapted to the growing of coriander. In these regions, however, the weather during the harvest period is

frequently unfavorable and makes successful cultivation of the crop doubtful. The Pacific Northwest and the other irrigated sections of the Western States are probably best suited to the crop. Trial plantings under irrigation in the Southwestern States indicate that the crop could be a success there if planted late in fall, so that it will mature the following May.

Cumin

Cumin (*Cuminum cyminum*) is a small slender herbaceous annual widely cultivated in India and the Mediterranean region of Europe. The aromatic fruit (known in the trade as seed) is used as a condiment. Large quantities are used in the preparation of curry and in combination with other aromatic seeds in flavoring sausages, cheese, and numerous other food products. The seed has not been produced commercially in the United States.

The plant thrives best on a well-drained rich sandy loam in regions where temperatures are mild and equable during a growing season of about 3 or 4 months. It is grown from seed. In the Mediterranean region the seed is frequently broadcast after winter crops of cereals, potatoes, or cabbage. Complete control of weeds is necessary because the plant is small and tender. For this reason planting the seed in rows spaced to permit maximum use of cultivators would be preferable in regions where hand labor is costly.

The crop is ready for harvest when the plants wither and the seed loses its dark-green color. In the Mediterranean region the plants are cut by hand and allowed to dry, and the seed is then beaten out with sticks, after which it is further dried and then cleaned of dirt and other extraneous matter. In this country, if grown on a large scale, it would have to be harvested in a more economical way. Drying in shocks and threshing with a modified grain thresher would probably be feasible. In general, the harvesting of cumin involves the same problems as that of the other condiment seed crops. The yield is reported to range from 100 to 1,000 pounds of seed per acre, with 500 pounds a fair average under reasonably good conditions.

Cumin is adapted to the Gulf Coast and Pacific Coast States, but harvesting will be less of a problem if the crop is grown under irrigation in the dry regions in the West and Southwest. The hand labor required by the tender nature of the plant and the rather limited yield of seed that may be obtained suggest that the profit from the crop would be small.

Dandelion

Dandelion (*Taraxacum officinale*) (fig. 20) is a well-known and troublesome perennial weed, occurring abundantly almost everywhere in this country except in the Southern States. The root is used in medicine.

This plant will grow well in any good soil. The seed is planted in spring in rows 18 inches apart and covered one-half inch deep. The seedlings are thinned to stand 1 foot apart in the row, and the crop is well cultivated and kept free from weeds. The roots are dug in the fall of the second season. They are washed and dried whole, or cut into pieces 3 to 6 inches long and the larger portions sliced. Under favorable conditions, yields at the rate of 1,000 to 1,500 pounds of dry roots per



FIGURE 20.—Dandelion.

acre have been obtained. A serious objection to growing this crop is the danger of seeding adjacent land with an undesirable weed.

Digitalis

Digitalis (*Digitalis purpurea*) (fig. 21), also known as foxglove, a fairly hardy European biennial or perennial, has long been grown as an ornamental in flower gardens in this country. *Digitalis* leaves and their products are heart-ailment medicines, and no satisfactory substitute for them has been introduced. The numerous horticultural forms developed differ principally in the size and color of the flowers. All are known to be medicinally potent, and their leaves are therefore acceptable for drug purposes. The species also grows wild in the general

region of the coast ranges of mountains in the northern Pacific Coast States.

There are several sources from which the supplies of digitalis used in American medicine are obtained. Most of it is imported from Europe. Another important source is the wild plant in the Pacific Northwest. The quantity of leaves collected there is undetermined, and no statistics on the subject are available. The third source is the small acreages of cultivated plants grown by manufacturers of digitalis products for their own use and, in recent years, the limited production on farms in Pennsylvania, Wisconsin, and the New England States, where its culture has been attended with considerable success.

The plant thrives in ordinary well-drained soils of open texture and reasonable fertility. Propagation is by seed. Direct field sowing is not usually successful, because the seed is exceedingly small and does not germinate well except under favorable conditions. To facilitate even distribution it may be mixed with sand and sown early in February in flats in a greenhouse or in a hotbed. When danger of frost is over, the plants are hardened off and transplanted to the field about 1 foot apart in rows conveniently spaced for cultivation. They do not bloom until the second season. Mulching for winter protection is advisable where very low temperatures prevail. The plant is usually cultivated as an annual or biennial crop although it also grows sometimes as a perennial.

Digitalis is extremely susceptible to damage by the common spider mite, especially in regions where hot dry periods are common. Control of this pest with the use of insecticides is difficult on account of the nature of the plant. The large leaves form a dense rosette, especially in the first year, and this makes it difficult to get adequate contact of insecticides with all surfaces whether applied as dust or spray. If not controlled, any considerable infestation of this mite ruins the crop.



FIGURE 21.—Digitalis.

The fact that damage from this cause has not been frequently reported in the North is good reason for restricting the acreage of this crop to that section.

Leaves are harvested the first year in fall. Cool weather is favorable to growth and it is therefore good practice to delay harvest as late as weather permits. If the plants survive the winter or are not destroyed when the leaves are harvested they produce flower stalks early the next season, but the yield of leaves that can be obtained then is much smaller than the first-year crop. The leaves are dried in the shade, in the way described under belladonna (p. 26). The medicinal quality of this drug is easily impaired by exposure to light and moisture, and it is therefore best stored in tightly closed metal containers.

The yields obtained from cultivated digitalis appear to vary greatly. Occasional yields at the rate of more than a ton of dry leaves to the acre are reported from small areas, but in most cases the yield may be expected to be 500 to 1,000 pounds.

Digitalis can be grown easily in many localities in the Northern and Western States and produces a crop the first year. Its successful cultivation for years by manufacturers of digitalis products and on farms in the Northern States indicates its possibilities and is evidence that a drug of good quality can be grown in the United States. In a favorable location, however, only 75 acres would be required to furnish the quantity of the drug usually imported annually. Experience indicates that its culture is best undertaken in the Northeastern States from Virginia north and west to Iowa and Minnesota. Some areas in the Mountain States also are suitable, and in regions of the Pacific Northwest where the plant grows wild its cultivation may be expected to be successful.

The wild plants in the Pacific Northwest can furnish much larger supplies of the drug than have been obtained from that source in the past. Methods of collecting the leaves and drying them in the commercial fruit and hop driers used in that section have been developed recently, and the cost of thus furnishing a product of acceptable quality is believed to be substantially less than that of producing it from cultivated plants.

Dill

Dill (*Anethum graveolens*) (fig. 22) is an annual or biennial plant often grown in gardens for the herb and seeds (fruits), which are used for flavoring foods and pickles. It is grown as a commercial crop in the North Central States, where it is used by pickle manufacturers. The volatile oil, which may be distilled from the same material, is now to some extent replacing the dill herb, and limited acreages of dill are being grown for oil production. Some years ago the oil was produced mainly in Indiana, but at present Oregon is the principal source.

Although a native of southern Europe, dill will grow well in a much cooler climate. On fertile loam soil it will grow to a height of 3 or 4 feet and make a good seed crop in the Northern and North Pacific Coast States. If planted early in spring, dill will produce seed the same season, but, if conditions do not permit prompt germination and rapid early growth, the plants may not reach full development and will produce only a small seed crop. Good results have been obtained by late fall sowing so the seed can germinate as soon in spring as conditions become favorable. The seed is drilled in rows usually 1 to 3 feet apart, depending



FIGURE 22.—Dill.

on the method of cultivation to be followed for weed control. The plants must be thinned when about 3 inches high, and the distance between plants in the row may vary from 6 to 15 inches. A better seed crop will be obtained if the plants are not too crowded.

The progressive ripening of the seed and the tendency of fully ripe seed to shatter present the same difficulties in harvesting as in other aromatic seed crops. The best practice seems to be to mow the plants when the earliest seed is ripe. In very dry weather this is preferably done early in the morning when the plants are damp with dew. The harvested material may be left in the field in small cocks until dry, when the seed can be easily threshed out. In small plots the upper parts of the plants can be cut by hand and the material deposited on canvas sheets, in which it is taken from the field when dry, thus avoiding loss

from shattering. In adverse weather it can be taken directly to a barn or outbuilding and dried under cover. The threshed seed must be spread out in a thin layer and stirred frequently until thoroughly dry.

When the crop is grown for oil it must be harvested at exactly the stage when the flavor of the oil will be that of the herb as it is generally used. This stage is reached when the fruit is fully developed but has not turned brown. The crop is cut with a mower and, after partial drying in the field, is distilled with steam.

The yield of seed is reported to be 500 to 700 pounds per acre. Data on the yields of oil are lacking, but it has been reported that 20 pounds may be expected under good conditions.

Dill can be grown in the North Central States, the North Pacific Coast States, and possibly in some of the cooler irrigated valleys in the West, where the drying and curing of the crop would be simpler than in more humid regions. Dill culture on a commercial scale for the production of seed for the condiment trade does not appear to offer much opportunity. The fact that it can be grown as an annual and requires no seedbed propagation are favorable factors, but the market outlet is limited and the gross returns are not large. As in the use of other condiment seed crops, loss of seed by shattering and the fact that harvesting must be done at just the right stage may make it difficult to fit the crop into general farming operations. As a source of oil it can best be grown by farmers who grow mint or other essential-oil crops and have special distilling equipment already on hand. Abandonment of this crop in the Midwest was due to a reduction in the market value of the oil. It is claimed that at the price level that has generally prevailed in recent years the crop is not profitable enough to displace better known crops in that section.

Echinacea

Echinacea (*Brauneria angustifolia*) (fig. 23) is a native perennial plant found on the prairies of the Middle West, most abundantly in Nebraska and Kansas. The roots are used medicinally.

This plant has been found to do well under cultivation in moderately rich and well-drained loam. It grows fairly well from seed, which is planted thinly in a well-prepared seedbed in drills about 8 inches apart. The plants develop slowly and may be left in the seedbed for 2 years and then transplanted to the field in spring and set about 18 inches apart in rows. Thorough cultivation is essential for best results. The roots do not reach a marketable size in less than 3 or 4 years. They are harvested in fall, freed from soil, and dried either in the open air or with low artificial heat.

Echinacea has not been cultivated on a scale large enough to give satisfactory data on the probable yield. It is not a promising crop on account of the slow growth of the roots and their relatively low market value.

Elecampane

Elecampane (*Inula helenium*) (fig. 24) is a European perennial plant now growing wild along roadsides and in fields throughout the northeastern part of the United States. The root is used in medicine. Elecampane will grow in almost any soil but thrives best in deep clay loam well supplied with moisture. The plant is best propagated by



FIGURE 23.—Echinacea.

divisions of old roots, which are set in the field in fall about 18 inches apart in rows 3 feet apart. Plants can also be grown by sowing seed in spring in seedbeds and setting the seedlings in the field in the same manner as the root divisions. Those grown from seed do not flower the first year. Cultivation should be sufficient to keep the soil in good condition and free from weeds.

The roots are dug in the fall of the second year, thoroughly cleaned, sliced, and dried in the shade. The available data on yields indicate that 1 ton or more of dry root per acre may be expected.



FIGURE 24.—Elecampane.

Fennel

Fennel (*Foeniculum vulgare*) (fig. 25) is a herbaceous perennial occasionally cultivated as a garden herb in the United States. The dried aromatic fruits, commonly referred to as seed, are used for flavoring bread, pastry, candies, and liqueurs and in medicine. A volatile oil is

present in the seed and may be obtained from it by steam distillation. It possesses the characteristic flavor of the seed and is used for flavoring and medicinal purposes. The several varieties of fennel are quite different in growth habit. The Indian fennel matures at about $3\frac{1}{2}$ to 4 feet in height when grown under favorable conditions. The Moroccan variety requires about 3 weeks longer to mature and grows about 6 feet tall.

Fennel grows well in a fairly mild climate and on almost any good soil but thrives best on nonacid, well-drained loams. It is readily grown from seed but can also be propagated by root and crown division. The seed is sown thickly directly in the field late in fall or early in spring, in rows 3 or 4 feet apart and covered lightly. When well established the plants are thinned to stand 8 to 12 inches apart in the row. The plants



FIGURE 25.—Fennel.

can also be started in a seedbed and transplanted to the field when 3 or 4 inches high. The cultivation required is the same as for ordinary garden crops. If the plants are grown as a winter crop in the warmer valleys of the Southwestern States the tops are injured by winter freezing, but they will make a good growth under favorable conditions early in spring.

Frequently very little seed is produced the first year, but full crops can be expected in succeeding years. The seed is harvested when it is sufficiently hard and has a greenish-gray color. It is borne on umbels, and, although all the seed on an umbel matures within a fairly short time, not all the umbels develop on the plant at the same time. If hand harvesting is resorted to, it is possible to gather the more mature umbels

first and then go over the plants once or twice later when the remainder have matured. The harvested material must then be dried by spreading it on a dry floor or on screens in some suitable building or in the open if the weather is favorable.

To harvest the crop in this way is tedious and requires much labor, but it appears to be the only way if all seed is to be gathered when it is in the most desirable stage. Cutting the entire tops at one time with suitable machinery, stacking it in the field until fully cured and dry, and then threshing with a modified grain thresher seems the only possible procedure for handling the crop at low labor cost. In that case, however, some seed will undoubtedly be lost—if it is too ripe it will shatter and if too immature some of it will not be of good quality when cured.

The yield of fennel seed is estimated to be from 600 to 800 pounds per acre, although yields from small experimental plots have in some cases indicated substantially larger yields.

Fennel is believed to be adapted to the Central and Northern States and probably to some sections of California, where it has escaped from cultivation in some places and grows to large size. Economical harvesting without considerable loss of seed seems improbable, and the yield of seed and gross returns are not believed adequate to justify much hand labor. The demand for fennel, moreover, is limited, since less than 500 acres are needed to supply the normal annual domestic requirement. Aphids cause severe damage to fennel, and its culture is not recommended for localities where these cause damage to other plants.

Gentian

The common, or yellow, gentian (*Gentiana lutea*) is found in the mountainous regions of southern and central Europe. The root is used extensively in medicine, as indicated by the quantities imported.

The plant is poorly adapted to cultivation outside its natural range, and experimental plantings in this country have not been encouraging. It appears to require partial shade and would probably best be grown as a companion crop to ginseng and goldenseal in open woodland or under an artificial shade structure and with much the same cultural methods. It is a slow-growing plant and takes several years to produce a marketable root. Information concerning the yield of root is entirely lacking.

Gentian is probably best adapted to the milder mountain sections of the Eastern and North Pacific Coast States where ginseng and goldenseal are now grown. The crop is not likely to be profitable because of the long time required to develop the roots and their relatively low value.

Ginger

Ginger (*Zingiber officinale*) (fig. 26) is a biennial or perennial herb native to the Tropics and cultivated in tropical countries in both hemispheres. The rhizome (the underground stem often referred to as the root), which has a characteristic, pungent taste, is used to some extent in medicine, but its principal commercial use is in flavoring foods, confections, and carbonated beverages. Ginger is handled in the trade under various names that indicate its geographic source, such as Jamaica, East Indian, African, and Cochin. It occurs on the market in several forms, determined by the method by which it is prepared. There is no commercial source of ginger in the United States, although the plant has

been introduced in southern Florida, where it is well adapted and where some experimental plantings have been made.

Ginger is an exhaustive crop and requires a fertile soil with good drainage. The rhizomes are likely to rot in poorly drained soil, and the plant will not thrive in gravelly or sandy soil. For maximum growth much rain and high temperatures during the growing season are required, and it is therefore best grown in tropical and subtropical regions.

Since the rhizomes may be harvested early in winter, however, and the crop will not be replanted until early in spring, its culture need not be restricted to regions that are entirely frost-free. Ginger is readily propagated from small divisions of the rhizomes, each division containing at least one bud or so-called "eye." In Florida, these may be planted in February or early March about 3 inches deep and about 16 inches apart in rows 2 feet apart. Experiments there have shown that the plants come up slowly and in the early stage of growth are much benefited by some protection from the sun. Cultivation and hoeing sufficient to control weeds is necessary. As the season advances and the rhizomes enlarge, the plant develops numerous leafstalks, followed in fall by flower stalks.

In Florida the roots may be harvested early in December. This is readily accomplished with a garden fork, but in large commercial plantings machinery could be developed for harvesting the roots at lower cost. The soil is shaken off, the top cut off close to the rhizomes, and the fibrous roots removed. To facilitate removal of the soil, it is advisable to break the rhizomes into its several branches, or "hands." Beginning at this stage the handling varies according to which of two classes of commercial ginger it is desired to produce, preserved or dried ginger.

Preserved ginger is produced mainly in China from immature rhizomes that have not acquired full pungency. The procedure includes thorough washing and successive boiling in three or four portions of a sugar solution for 1 or 2 hours until the rhizomes are thoroughly soaked.



FIGURE 26.—Ginger.

They are then placed in suitable containers and covered with syrup or drained until dry and then rolled in sugar.

For dried ginger, the treatment of the rhizomes depends on whether it is to be sold as unpeeled or peeled ginger. The unpeeled product occurs in the trade as either "green" or "black" ginger. The "green" is obtained merely by drying the rhizomes after removing the soil and roots. If the weather permits, sun drying is satisfactory and economical, but the use of artificial heat has many advantages, although it is more costly. To produce "black" ginger, the cleaned rhizomes are scalded in boiling water and then rapidly dried. For the production of peeled ginger, a thin layer of the skin of the rhizomes is removed with special care to prevent loss of the oil cells, which are close to the surface. The peeled rhizomes are immediately placed in water and washed. Various substances may be added to the water to improve the whiteness of the rhizomes, but this practice is generally discouraged. The cost of labor involved in making peeled ginger would probably make production in the United States economically impossible.

The yields of dried ginger per acre reported from different sources vary greatly, but under favorable conditions about 1,200 pounds are probably obtained in Jamaica. In limited small-scale experiments with the crop in central Florida, the indicated yield was only about half as much.

The subtropical section of southern Florida is believed to be the only region in continental United States where the climatic conditions for ginger culture are favorable. On the basis of quantities imported and estimated yields 800 to 1,000 acres could be used for this crop. Ginger could perhaps be grown best by those engaged in truck-crop production in the trucking areas of southern Florida. The cost of labor required for properly cleaning the rhizomes may be an important factor in determining net returns. Diseases and insect pests also are factors, the importance of which cannot be estimated at present, because there is no information concerning probable insect and disease damage under Florida conditions.

Ginseng

Ginseng (*Panax quinquefolium*) (fig. 27) is a fleshy-rooted herbaceous plant native to this country and formerly of frequent occurrence in shady well-drained situations in hardwood forests from Maine to Minnesota and southward to the mountains of the Carolinas and Georgia. The roots have long been believed by the Chinese to possess pronounced medicinal value. During the 5-year period 1936-40 the exports of roots to China ranged from 136,000 to 295,000 pounds. According to the Agricultural Census Report of 1940 there were 138 acres of ginseng in the United States in 1939, of which 73 acres were in Wisconsin.

Ginseng must be grown in partial shade in open woodland or under lath structures. The soil must be fairly light and well fertilized with woods earth, rotted leaves, or fine raw bonemeal, the bonemeal applied at the rate of 1 pound to each square yard. Seed is planted in spring as early as the soil can be worked to advantage. It is placed 6 inches apart each way in the permanent beds or 2 by 6 inches in seedbeds, and the seedlings are transplanted to stand 6 to 8 inches apart when 2 years old. The roots of ginseng plants, especially in woodland, are sometimes damaged by mice. Protection from these rodents may be



FIGURE 27.—Ginseng.

necessary. The beds should at all times be kept free from weeds and grass and the surface of the soil slightly stirred whenever it shows signs of caking. A winter mulch is needed, applied when freezing weather begins and removed early in spring.

The roots do not reach marketable size until about the fifth or sixth year, when they are dug and carefully washed or shaken free from all adhering soil. The trade accepts only whole roots; hence they must be dried in that form. This is best done in a well-ventilated room heated to about 90° F. Considerable time is required to cure the larger roots properly, and much care must be taken to prevent overheating and molding. When well cured the roots should be stored in a dry airy place until ready for sale. A market may be found with the wholesale drug

dealers who export the root to China. Persons interested in ginseng growing should learn fully from reliable sources about the problems involved in handling this crop and should not be misled by the exaggerated claims that have been made concerning the profits to be derived.¹⁰

Goldenseal

Goldenseal, or hydrastis (*Hydrastis canadensis*) (fig. 28), is a native perennial formerly abundant in open woodlands having good natural drainage and an abundance of leafmold. Its range is from southern



FIGURE 28.—Goldenseal.

¹⁰ For more complete information, see Farmers' Bulletin 1184, Ginseng Culture.

New York and Ontario, west to Minnesota, and south to Kentucky and Georgia. The rhizome and roots comprise the official drug, but the herb is used to some extent for the extraction of alkaloids. In 1939 there were 50 acres of goldenseal under cultivation in the United States according to the Census Report of 1940. Four-fifths of this was in the Pacific Northwest.

Like ginseng, goldenseal must be grown in open woodland or under lath shade. The soil should be well fertilized, preferably by decaying vegetable matter, such as woods soil and rotting forest leaves, well worked in to a depth of 10 inches or more. Raw bonemeal and cottonseed meal can also be used to advantage. Seed may be broadcast or planted in October half an inch apart in rows 6 inches apart in a well-prepared seedbed and covered with fine leafmold to the depth of 1 inch. In winter the seedbed should be protected with burlap or fertilizer sacks. The seedlings when large enough, usually at the end of the second season, are transplanted to their permanent beds 6 to 8 inches apart each way, the rootstocks covered to a depth of about 2 inches. The soil should be kept free from weeds and the plants liberally watered throughout the growing season. For satisfactory growth the plant requires about 75 percent of shade during the summer.

Under favorable conditions goldenseal reaches its best development in about 5 years from seed, or in 1 or 2 years less when grown from root buds or by divisions of the rootstocks. The roots are dug in fall after the tops have withered. They are washed clean of all soil and dried on lath screens in an airy place in mild sunlight or partial shade, or indoors on a clean dry floor. When dried in the open they should be protected from rain and dew. The dried leaves and stems of goldenseal, commonly known as seal herb, are also a marketable product.¹¹

Henbane

Henbane (*Hyoscyamus niger*) (fig. 29) is a poisonous annual or biennial herb introduced into this country from Europe and occasionally



FIGURE 29.—Henbane.

¹¹ Further details on culture are given in Farmers' Bulletin 613, Goldenseal Under Cultivation.

found as a weed in some of the Northern and Great Plains States. The herb (leaves, flowers, and small stems) contains several poisonous alkaloids used in the preparation of important medicines. The plants growing wild are probably not utilized as sources of the drug to any important extent when material is available from Europe, but substantial quantities are collected here in times of high market prices.

The soil and climatic requirements of henbane are very similar to those of belladonna, but the plant is less subject to root decay under poor drainage conditions. The seed germinates uniformly in about 2 weeks. Open field sowing, however, is not generally recommended. Good results have been obtained by sowing the seed in flats in a greenhouse in midwinter, transplanting the seedlings in 3-inch pots in March, and transplanting them to the field in May. The plants may be set about 15 inches apart in rows spaced at least 30 inches apart. Since the small plants grow slowly, hoeing and weeding may be necessary to control weeds. During the first year this crop is likely to be damaged or destroyed by potato beetles and flea beetles where these pests are found, especially when the plants are small, unless effective insecticides are used. The early and rapid growth of the plant in the second year enables it better to withstand the ravages of these pests.

If the annual type is grown the crop is harvested when the plants are in full bloom. The biennial type makes a large rosettelike growth the first year and blooms early in the second season. Some growers prefer not to disturb the crop the first season and harvest it when in full bloom the second year. Others have found it more profitable to harvest the leaves late in the summer of the first year as well. As the plants do not always survive the winter, whether the leaves have been harvested or not, it may be more profitable to replant annually.

Henbane is harvested and dried in the same manner as belladonna. The yield under favorable conditions is estimated to be 500 to 700 pounds of dry herb per acre.

Henbane is adapted to the same soil and climatic conditions as belladonna. During the first world war a substantial acreage in Michigan brought large returns, and success also attended its culture in southern California. During the second world war the crop was again grown in these and several other States. One objection to growing it as a biennial is that no returns are obtained the first year, but in the regions where the growing season is sufficiently long a short-season follow-up crop can sometimes be grown after the second year harvest. As in the case of belladonna, adequate drying facilities must be provided, but the nature of the henbane herb is such that it is more difficult to dry than belladonna. The soil adheres more readily to it, thus necessitating greater care in handling at harvesttime. Henbane is extremely susceptible to a virus disease for which no control measures are known. It is estimated that less than 200 acres in a favorable location are required to produce the quantity of herb annually used.

Horehound

Horehound (*Marrubium vulgare*) (fig. 30) is a hardy perennial herb and occurs as a common weed in many places in the United States, especially on the Pacific coast. The leaves and flowering tops are in some demand as a crude drug. Their greatest use is in the manufacture of horehound candy, although they are sometimes employed for seasoning.



FIGURE 30.—Horehound.

The plant grows well in almost any soil and thrives in those that are light, dry, and rather poor. It grows readily from seed, which is usually sown in drills early in spring and covered with about 1 inch of soil. Plants can be started in coldframes, from either seed or cuttings, and later transplanted to the field, or divisions of old plants can be used. Plants may stand 6, 12, or 18 inches apart in the row; those standing close together have small stems and hence yield a crop of finer quality.

The crop is harvested just before full flowering and cured in the shade in order to preserve the green color. If the stems are small the plants may be cut close to the ground with a scythe or, if the area is large, with a mower. Large stems must be cut some distance above the ground and all coarse stems removed to make the herb acceptable to buyers. Yields at the rate of 2,000 pounds of dry herb per acre have been obtained.

Larkspur

Larkspur (*Delphinium ajacis*) (fig. 31) is an annual European plant introduced as an ornamental in this country. It has escaped in some sections. The seed is used in medicine.

The plant grows in any good garden soil but thrives especially in a rich sandy loam, deep preparation of which is important. For garden culture the seed is usually sown in fall. The only commercial production for the drug trade has been in Santa Barbara County, Calif., where a double-flowered variety, which produced the most seed, was grown during the war. There the seed is drilled in rows about 3 feet apart in

spring. The plants reach a height of 3 to 4 feet at the blooming stage. When the seed is ripe late in August the plants are harvested with a specially designed mowing machine used for harvesting flower seed crops. The cut plants are elevated into a trailer and hauled to a large canvas spread on the ground. It is piled on this and left for 10 or 12 days to dry. When thoroughly dry the seed is threshed with a special combine, cleaned, and bagged.



FIGURE 31.—Larkspur.

It is reported that about 100 acres of the crop were grown for several years and that the yield of seed was about 200 pounds per acre.

Lavender

The true lavender (*Lavandula officinalis*) (fig. 32) is a small shrubby plant native to southern Europe and widely cultivated for its fragrant flowers and for the oil distilled from the fresh flowering tops.



FIGURE 32.—Lavender.

The plant thrives best in light and rather dry soils well supplied with lime, but can be grown in almost any well-drained loam. On low or wet land it is almost certain to winterkill. The plant can be grown from seed, but is more readily propagated from cuttings or by division. In cold climates the plants must be well protected in winter. Early in spring the seedlings or rooted cuttings are set in well-prepared soil, 12 to 15 inches apart in rows spaced to suit the cultivation intended. Frequent and thorough cultivation is desirable.

Growth is slow, and the plants do not produce any considerable quantity of flowers for several years, but full crops may be expected for sometime thereafter if the plants are given proper care. The flowering tops are harvested when in full bloom, and if used for the production of oil are distilled at once without drying. If the dry flowers are wanted, the tops are carefully dried in the shade and the flowers later stripped from the stems by hand.

The 600 to 1,200 pounds of fresh flowering tops per acre that have been obtained will yield 150 to 250 pounds of dry material. The quantity of flowers that can be separated from this depends mainly on the method of harvesting, which determines the proportion of flowers and stems present. The yield of oil varies widely, but 12 to 15 pounds per acre can be expected under good conditions.

Licorice

Licorice (fig. 33) is derived from two closely related perennial herbs (*Glycyrrhiza glabra* and *G. glandulifera*) native to southern Europe, northern Africa, and western Asia. The rhizome and root (usually called root) are used in medicine, confections, and to a much more important extent in various tobacco products. There has never been any production of licorice in the United States. Attempts to introduce licorice as a crop were made many years ago in Florida, Louisiana, and California, but these were not successful, and there is very little reliable information concerning these attempts.

Licorice thrives best in warm regions where the growing season is sufficiently long to promote strong growth. The plant requires deep and sandy soil of good fertility and does not thrive on heavy soil in which the rhizomes cannot penetrate easily to considerable depth. It may be



FIGURE 33.—Licorice (*Glycyrrhiza glabra*).

grown from seed, but the usual practice is to propagate it from cuttings of the younger parts of the rhizomes, from suckers, or by crown divisions. These are planted in spring about 18 inches apart in rows spaced to permit cultivation necessary for weed control.

Licorice grows slowly and does not develop rhizomes of marketable quality in less than 3 or 4 years. Harvesting therefore usually is undertaken the third year after the herbaceous growth of the season has died. Owing to the depth of the rhizomes this must be delayed until rains make it possible to dig them without losing much of the younger growth. The harvesting involves much hand labor, especially where the rhizomes grow deep. The soil must be turned over to considerable depth and the rhizomes pulled out by hand. Usually the crowns are carefully separated from the rhizomes and divided and used for replanting.

The handling of the rhizomes varies greatly in the different regions in which licorice is produced. The single purpose in all cases is to reduce the moisture content so that the weight of the rhizomes is about half the fresh weight. In some regions they are piled up in stacks in the field, these stacks being turned over occasionally. Elsewhere they are stored in cellars and frequently stirred. Heating or sweating while in piles is detrimental to quality. Imperfectly dried rhizomes and roots may mold or decay when baled for shipment and in that condition are rejected by the trade. More practical methods will have to be developed before large acreages can be grown in this country. The yield of dry rhizomes and roots from 3-year-old plants are reported to average about 5,000 pounds per acre.

The sandy and sandy loam river valleys in the Southwestern States and in Texas are believed to be well adapted to licorice growing. To produce the quantity of roots used in this country annually a large acreage could be devoted to this crop, but a number of unfavorable aspects about its culture make the undertaking doubtful. The cost of harvesting is probably excessive even if a practical implement for the purpose is made available. It has been reported that parts of the rhizomes and roots left in the ground will under some conditions start to grow and thus establish a plant that may be difficult to eradicate later if the land is devoted to other use.

Lobelia

Lobelia (*Lobelia inflata*) (fig. 34) is a native poisonous annual plant, occurring most abundantly in open woods and pastures in the States east of the Mississippi River. The leaves, tops, and seeds are used medicinally.

This plant thrives under cultivation in a rather rich moist loam and grows well either in the open or in partial shade. It grows from seed, which is sown either in fall or spring in rows 2 feet apart. Since the seed is small the soil must be well prepared. It is best not to cover the seed but to sow it on the surface, which is then firmed by any practical means. Fall planting usually gives a better stand and a heavier crop. Shallow cultivation should be given until the plants begin to flower. A better method but one that requires more hand labor is to sow the seed in fall in an outdoor bed prepared as for tobacco seed and transplant the seedlings in spring.

Lobelia is harvested when in full flower or as soon as some of the older seed pods are full grown. The plants may be cut with a mower if the cutter bar is set high enough to avoid including the large stems. The herb should be dried in the shade in order to preserve the green color. Small areas have given yields at the rate of 1,000 pounds of dry herb per acre.

Lovage

Lovage (*Levisticum officinale*) (fig. 35) is a perennial plant introduced from Europe. It has been grown occasionally as a garden plant. The root has long been supposed to have medicinal properties and is in some demand in the drug trade. The flowering tops yield a volatile oil, but



FIGURE 34.—Lobelia.

there is little demand for it. The seed, leaves, and root are also used for flavoring foods.

Lovage grows well in almost any deep well-drained soil that will produce a fair crop of corn or potatoes and is benefited by the liberal use of fertilizer, although heavy applications of manure tend to produce excessive top growth. It is propagated from seed or by root divisions. The seed may be planted in the field in fall and lightly covered in rows 18 inches apart or sown in early spring in a hotbed, greenhouse, or well-prepared seedbed in a sheltered part of the garden and covered very lightly with sand or fine sifted soil. It is advisable to spread old burlap



FIGURE 35.—Lovage.

or other sacking over the bed and sprinkle it occasionally in dry weather. When the first seedlings break the soil the cover should be removed. The plants reach a size suitable for transplanting by the end of May, when they are set 8 inches apart in rows spaced for convenient cultivation.

The roots may be dug in October of the second or third year after setting the plants. Numerous offsets will generally be found, and if

these have good roots they may be reset at once to renew the planting without recourse to seed. The freshly dug roots are washed, cut into slices about half an inch thick, and carefully dried. Artificial heat, not to exceed 125° F., may be used to hasten the drying. Returns from experimental areas indicate that under good conditions a yield of 1,000 pounds of dried root to the acre may be expected every third year.



FIGURE 36.—Marjoram.

Marjoram

Marjoram (*Origanum majorana*) (fig. 36) is a widely cultivated perennial plant native to the Mediterranean region. It is commonly known as sweet marjoram, as distinguished from a related species, and is characterized by a pleasant, fragrant, spicy odor and flavor that makes the herb very popular for seasoning soups, stews, dressings, and similar dishes. Although widely grown in the United States in gardens for home use and for limited sale in local markets, this herb has not been grown on a commercial scale.

The plant grows well in any well-drained fertile garden loam. Although primarily a warm-climate plant, it makes good growth in cooler regions but is very subject there to winterkilling unless well mulched with straw or leaves. For this reason it is often grown as an annual. The seed is small and is best started in the greenhouse, the seedlings being transplanted to the field after all danger of frost has passed. Propagation by cuttings is also entirely practical.

Under some conditions some herb can be cut from the plants several times during the summer, but there appears to be no real practical way of harvesting marjoram other than by cutting the entire plant at the ground and drying the herb. Moderate quantities can be handled by spreading the herb on floors, screens, or racks in a well-ventilated building. For large acreages a more practical way would have to be found. When the herb is dry the leaves and small stems are removed from the more woody parts by flailing or any other practical means that can be devised. Information concerning the yield of this herb is almost entirely lacking, but the results from experimental plantings abroad suggest that up to 1,500 pounds per acre may be possible.

Marjoram can be grown in many sections of this country, as an annual in the Northern States and as an annual or perennial in the South and on the west coast. It cannot be widely recommended as a cash crop, however, because less than 100 acres would probably be sufficient to meet all the domestic requirements. Growers of other herbs, such as sage, who have satisfactory drying facilities and marketing arrangements, could probably grow some marjoram as a minor companion crop.

Melissa

Melissa (*Melissa officinalis*) (fig. 37), also known as lemon balm, is a perennial herb native of southern Europe and has long been cultivated in gardens in this country. In many places in the Eastern States it has escaped and is now growing wild. The leaves are widely used for culinary flavoring, and the leaves and flowering tops are used in medicine. The volatile oil distilled from the plant is said to be used in perfumery and also for flavoring.

Balm grows readily on any good garden soil and is easily propagated from seed or cuttings or by division. The seed is small and is best sown thinly in shallow flats in a greenhouse or in a hotbed on the surface of well-fined soil, which is then firmed. The seedlings are transferred to deeper flats when small and when 4 or 5 inches high are set in the field about 1 foot apart in rows spaced to suit cultivation, which should be frequent while the plants are small.

When the plants are in full flower the crop is cut with a scythe or mower. If the flowering tops are to be marketed the stemmy portions must be removed before or after drying or the crop harvested by some means by which only the part wanted is cut off. The material thus obtained is dried in the shade in order to preserve the green color. For the distillation of the oil the entire herb is used.

Yields at the rate of about 1,800 pounds of dry herb per acre have been obtained, but if only the flowering tops are collected the yield will be materially less, probably from 800 to 1,000 pounds. The yield of oil from the herb is small and estimates per acre are not available.



FIGURE 37.—Melissa.

Mustard

Commercial mustard seed is obtained from several closely related species and varieties of *Brassica*, which are annual plants of wide geographic distribution. The seeds of these varieties differ slightly in size and range in color from pale yellow to black. The most important varieties are the yellow (sometimes referred to as white mustard), the brown, and the oriental types, all of which are produced under cultivation. The principal use of the seed is as a condiment; however, it is also used medicinally. For this use the brown is preferred to the yellow, because it is more pungent. The several types differ in color of their seed coats only. When these are completely removed from the ground

seed the flour of any of them may be used for prepared mustard and other seasoning preparations. The yellow seed, unground, is used in pickling, especially in sweet, mixed pickles.

There are three sources of the commercial seed consumed in the United States: (1) Seed produced in the United States under cultivation; (2) seed from wild plants obtained from grain screenings; and (3) imports. Most of the domestic production is in California and Montana, with smaller quantities produced in other Western States. The annual production has varied greatly from year to year. In the 5-year period 1936-40 it ranged from 4,417,000 to 19,945,000 pounds. During the next 5 years, 1941-45, the production was much greater, ranging from 27,980,000 to 73,000,000 pounds. In Oregon, Washington, and Idaho the production has generally been between 1 and 2 million pounds since 1938, except in 1941 and 1942, when it was 13,325,000 and 5,985,000 pounds, respectively. In 1947 the total domestic production was 20,990,000 pounds. In most years more than three-quarters of the total domestic crop has been produced in Montana. There was considerable over-production during the war.

Yellow mustard is best adapted to a rather heavy type of sandy loam and light adobe soil, whereas the brown requires a lighter sandy loam. The crop requires only limited rainfall, preferably so distributed that the seed can mature during a period of dry weather. These conditions prevail in the principal producing regions. In the Lompoc Valley, in Santa Barbara County, Calif., the crop is also said to be favored by cool west winds and fogs. The land is best prepared in fall, the method depending on the cultural practices used with the preceding crop. Seed is broadcast in spring, using an alfalfa or grain seeder, after which the ground is harrowed. In California the brown seed is sown from January to March and the yellow seed near the end of this period. In Montana, seed is sown from early spring to the first of June. About 3 pounds of brown or 4 pounds of yellow seed are required per acre.

The crop is usually ready for harvesting in August. The seed shatters severely when it is fully ripe and the crop must, therefore, be harvested when the pods are fully grown but still closed. In California two methods are employed, depending on the equipment and facilities available. The crop is cut with a mower and allowed to dry in windrows, from which it is threshed with a pick-up harvester when dry; or it is cut and bound with a grain binder, cured in the field, and then threshed with a modified grain thresher. In Montana most of the crop is harvested with a combine.

The brown variety produces heavier yields than the yellow. In California the former is reported to yield from 1,200 to 1,500 pounds to the acre and the latter 800 to 1,000 pounds. In Montana the yields are dependent on the rainfall during the growing season. The average annual yields per acre in that State over a period of years have ranged from 115 to 548 pounds, but individual growers have reported yields as high as 1,500 pounds. Generally if the yields are good the quality also is good.

Mustard is definitely a crop for the Western States for climatic reasons. Elsewhere frequent rains when the crop matures may interfere with proper and timely harvesting and result in loss of seed. It has been successfully grown in the Western States, since it is an annual crop yielding early returns, is not difficult to grow, and can be handled with equipment usually available on large farms. Soil and climate apparently

have a pronounced influence on the quality of the seed. In new localities, especially where conditions are quite different, it is advisable first to grow a small trial acreage to determine whether the seed produced is of acceptable quality. The species and varieties of mustard grown can become established as weed pests.¹²

Orris

Orris root is obtained from three species of iris (*Iris florentina*, *I. pallida*, and *I. germanica*) (fig. 38), perennials native to southern Europe



FIGURE 38.—Orris (*Iris germanica*).

and cultivated chiefly in Italy for their fragrant rootstocks. Powdered orris root is used principally as a scenting agent in perfumery and cosmetics. The plants grow well in a variety of soils and flourish in rich moist loam, but roots grown in rather dry, gravelly soil appear to be the most fragrant.

Orris is readily propagated by division of the old plants, which may be set either in spring or fall about a foot apart in rows spaced

¹² Additional information is available in a processed leaflet, DRP 45, The Production of Mustard Seed in the United States, issued by this Bureau.

conveniently for cultivation. It requires 3 years to produce a marketable crop of roots. After the roots are dug at the end of the third season they are peeled and dried in the open air. The desired fragrance does not develop until after the dry roots have been stored for a long time, during which they are especially liable to the attacks of insects. The yield is from 5 to 6 tons of dry root per acre every third year under good conditions.

The outlook for a profitable orris industry in this country is not promising. The horticultural varieties of iris so widely grown as ornamentals are not satisfactory sources of the root, and planting stock of the preferred species may not be available from domestic nurseries. The peeling is a tedious process and expensive unless cheap labor is available.

Paprika

Paprika is one of the less pungent of the varieties of red pepper (*Capsicum frutescens*) (fig. 39) and is widely used as a condiment. It has long been grown for export in eastern and southern Europe and successfully cultivated in the United States. The product varies considerably in quality, depending on which parts of the fruit are included in the processed material. The substance giving red peppers (p. 39) their pungent properties is produced almost entirely in the thin papery tissues of the placenta to which the seed are attached. Even in the mild paprika pepper this sometimes is somewhat pungent. The degree of pungency of ground paprika may therefore depend on the thoroughness with which the placenta are removed. Removal of the seed and placenta results in a mild product, while grinding the whole fruit results in a product of more pungency, but the seeds add a nutty, oily flavor. The so-called Spanish paprika is the milder type, the production of which calls for the complete removal of seeds and placenta, a procedure that by reducing the yield and adding to the cost, increases the market price.

The paprika type of red pepper was grown commercially in northeastern South Carolina in 1915 and 1916, when about 200,000 pounds were produced. This industry was the result of about 10 years of experimenting in that area. The crop was abandoned after 1916 in favor of cotton and other staples that were bringing good prices at that time and required less labor and attention. At present the only commercial acreage of paprika is in South Carolina and in the southern California coastal district. After the outbreak of war in Europe in 1939 a considerable acreage was planted in southern Louisiana, but the crop was not a success there.

The paprika pepper, like the related more pungent varieties, is well adapted to the warm areas in the Southern States from the eastern coastal plain to California. The long growing season in that region is adapted to the habit of the plant to fruit over a long period. Moreover, sunshine during the fruiting period adds brilliancy to the color of the fruit and causes more uniform ripening. If there is much rainy and cloudy weather at the blooming stage, the plants sometimes fail to set fruit, and if such weather prevails late in summer the fruit will not color properly and may be much damaged by disease.

The paprika pepper grows on a large variety of fertile soils but thrives best on a warm mellow well-drained sandy loam or clay loam type. The plant is propagated exclusively from seed, which may be



FIGURE 39.—Paprika.

planted in seedbeds or directly in the field. In beds the seed is sown as early in spring as possible, and the seedlings are then ready to be planted in the field as soon as the danger of frost has passed. They are spaced 12 to 18 inches apart, in rows 30 to 48 inches apart. If there is favorable weather early in spring the seed may be planted directly in the field by drilling in rows 3 to 4 feet apart and covering with 1 inch of soil. When the plants are 2 to 3 inches high they should be thinned

to stand 12 to 18 inches apart in the rows and missing places filled in as necessary. Frequent shallow cultivation is necessary, and this must be continued throughout the long growing period of the crop.

Fruits of various degrees of maturity are found on the plant in summer and fall because the flowers are produced over a long period. Only fully mature fruits should be picked. Therefore, the harvesting must extend over several months, and the field must be gone over at weekly intervals when good ripening weather prevails.

The drying and curing of the peppers requires clear hot weather or artificial heat in suitable structures. If heat is used, the picking must proceed no faster than the peppers can be cured by the facilities available. The periodic picking necessitated by the growth habit of the plant therefore fits in well with the method of curing and makes it possible to handle the crop with a minimum of curing facilities and structures where such must be provided.

Various methods of drying are in use. In some cases the peppers are placed in small-mesh bags and suspended in a building heated by a small stove or other convenient means. In others the peppers are put on wire-bottomed trays, 5 inches deep, stacked in a way to assure adequate movement of air, in a room where a temperature of 130° to 150° F. can be maintained by a hot-air furnace. The peppers lose about 85 percent of their weight in drying, which by the furnace method requires about 3 days. More rapid drying can be obtained with the so-called tunnel-driers, in which a strong current of heated air is used. In these the drying is completed in less than 30 hours if the fruit is punctured in several places to permit more rapid removal of moisture.

The yield of dried paprika under favorable conditions ranges from 1,000 to 2,000 pounds per acre. The highest average yields are probably obtained under irrigation in California where growing conditions are less variable. The crop may also have possibilities in the irrigated districts in New Mexico and Arizona, but the total annual consumption could be produced on only 5,000 or 6,000 acres. The gross returns, with good management, are larger than those from many of the staple crops, but paprika can be harvested by hand labor only, and this must be available from midsummer to fall. Throughout the season, paprika culture requires constant attention and supervision, and the grading and sorting after the crop is all harvested and cured calls for an additional period of labor and close attention by the grower.

Parsley

Parsley (*Petroselinum hortense*) is a biennial herb grown everywhere in gardens for use in garnishing and seasoning. All parts of the plant contain a volatile oil, that from the seed being especially rich in a constituent known as apiol, or "parsley camphor," which is used to some extent in medicine. In the crude-drug trade there is a small demand for the root, leaves, and seed.

A rich and rather moist soil is desirable for growing parsley. The seed germinates slowly and is sown early in spring in coldframes or seedbeds, from which the young plants may be removed later and set in the field at about 6-inch intervals in rows 12 inches or more apart. When the leaves are fully grown they can be collected and dried in the usual manner. The plants flower in the second year, and as soon as the seed is ripe it is harvested and carefully dried. At the end of the second

growing season, late in October, the roots can be dug, washed well, and carefully dried. Artificial heat can be used in drying if necessary. Information on yields of seed and root is not available.

Pennyroyal

Pennyroyal (*Hedeoma pulegioides*) (fig. 40) is an annual plant found in dry soils from Nova Scotia and Quebec to the Dakotas and southward. Both the dry herb and the oil obtained from it by steam distillation are marketable products.



FIGURE 40.—Pennyroyal.

Pennyroyal grows well on average upland soils and is frequently abundant on sandy or gravelly slopes. In field planting, the seed is sown in rows in fall and covered not to exceed one-quarter of an inch, since it rarely germinates if planted at a greater depth. It must be sown thick to assure a full early-spring stand, because much of it is lost in winter. For best results, clean cultivation and freedom from weeds are essential.

The crop is harvested with a scythe or mowing machine early in summer, when the plants are in full flower. The herb is dried, preferably in the shade, and the large stems are then removed to improve the quality of the product. As the herb deteriorates with age, it should be carefully packed and promptly marketed. For the production of the volatile oil the plants are harvested when in full bloom and distilled without drying.

Returns from experimental areas indicate that a yield of about 1,200 pounds of dry herb per acre may be expected. There are no reliable records on the yield of oil, but it is not likely to exceed 15 pounds per acre. The returns from the herb may be expected to be considerably greater than those from the oil.

Peppermint

Peppermint (*Mentha piperita*) (fig. 41) is a perennial herb frequently growing wild in moist situations throughout the eastern half of the United States. It is cultivated on a commercial scale on the muck lands in southern Michigan and northern Indiana and near Sacramento, Calif.; on similar soil and on upland in western Oregon and Washington; and under irrigation in the Yakima-Kennewick district of south-central Washington. The volatile oil, which is widely used for flavoring chewing gum, confections, and dentifrices and in medicines, is the principal marketable product, but there is some demand in the crude-drug trade for the dried leaves and flowering tops.

Peppermint can be grown on any land that will produce good crops of corn, but is most successful on the muck lands of reclaimed swamps. It is propagated by stolons, commonly called roots or runners, which are laid almost end to end in furrows about 3 feet apart and covered to a depth of about 4 inches. The first year the crop is grown as "row" mint, but in fall and the following year the plants spread all over the ground and thereafter for several years it is grown as "meadow" mint. It is essential that the ground be kept free from weeds, since their presence in the crop at harvest seriously reduces the quality of the oil. In meadow mint the weeds are somewhat controlled early in the season with rotary hoes and weeders, but later hand weeding is necessary. Peppermint is subject to a number of diseases. One of these, the so-called wilt, is extremely serious in some regions and under some conditions. The crop is attacked by a flea beetle and several other insects, which at times, unless controlled, cause much damage.

Harvesting is begun in July or August, when the plants are in full bloom. The crop is cut with a mower. If the herb is to be marketed as such for the crude-drug trade it is allowed to dry partly in the swath and is then placed in cocks in the field until fully cured. If leaves alone are desired these must be removed from the stems by any practicable means. If the oil is to be extracted the herb is fairly well dried in the swath, raked into windrows, and then distilled with steam. The yield



FIGURE 41.—Peppermint.

of oil varies considerably, but on lands well suited for the crop it will average about 30 pounds per acre in the Midwest and 40 pounds in the Pacific Coast States.

The annual production of peppermint oil in the United States in the period 1935 to 1947 ranged from 1,000,000 to 1,600,000 pounds, obtained from 35,000 to 50,000 acres. In Indiana, Oregon, and Washington the acreage of peppermint and the production of the oil have increased steadily as the annual consumption of the oil has increased. In Michigan the production has declined.¹³

¹³ For more complete information on the growing of peppermint see Farmers' Bulletin 1988, Mint Farming.

Pinkroot

Pinkroot (*Spigelia marilandica*) (fig. 42) is a native perennial herb occurring in rich open woods from North Carolina to Ohio and south to Florida and Texas. The root was at one time considered an important drug, but its use has declined in recent years. Although the plant is generally found under partial shade, it may be grown in the open in rich moist loamy soil. It is propagated either from seed or from divisions of old roots. The seed, which ripens in midsummer, should be sown immediately in drills 6 inches apart in a well-prepared seedbed or mixed with moist sand and kept in a cool place and sown in fall. In spring, when the young plants are a few inches high, they are set in their permanent location, spaced 18 inches apart in rows at least 3 feet apart. The



FIGURE 42.—Pinkroot.

old roots are divided when dormant, so that each division consists of a portion of the root with one or more buds and a number of the small rootlets. They are set in the same manner as the seedlings. Thorough cultivation to control weeds is necessary.

The roots usually attain marketable size in 3 years but will give a heavier yield at the end of the fourth or fifth year. They are harvested in fall and, after removal of the tops, are well washed and thoroughly dried. Little can be said regarding yields, but returns from small areas indicate that the dry roots will not exceed 500 pounds per acre after 4 years. It is not a promising crop.

Pokeroot

Pokeroot (*Phytolacca americana*) (fig. 43) is a native, perennial plant of frequent occurrence in moist rich soil along fences and in uncultivated land throughout the eastern half of the United States. The root and the berries are used in medicine. The seeds and the roots are poisonous.

Pokeroot thrives in deep rich soil well supplied with moisture and may be readily grown from seed sown early in spring in rows 4 feet apart and barely covered. The seedlings are thinned to stand about 3 feet apart in the row. Frequent shallow cultivation is required. The plant develops long, thick, fleshy roots. At the end of the first year these may be turned out without great difficulty by means of a deep-running plow, but when the plants are older they may have to be dug by hand. The roots are washed and cut either lengthwise or transversely and thoroughly dried. If a large quantity is to be handled the use of artificial heat will be found desirable.

A yield of about 600 pounds of dry root per acre may be expected at the end of the first year, and three or four times as much from plants of the second year's growth. In the second year several hundred pounds of berries also may be obtained from an acre. Apparently there is only a small demand for either the roots or berries, and since the plant is abundant in the wild state its cultivation may not be profitable.

Sage

Sage (*Salvia officinalis*) (fig. 44) is a hardy perennial herb native to the north Mediterranean countries and now cultivated in many temperate regions of the world. The green herb or the dried leaves are used in seasoning ground meats, soups, dressings, and poultry dishes. The oil, which gives the plant its flavoring qualities, is sometimes distilled from the herb and used for flavoring, especially in products that would be discolored by the leaves.

The plant has long been grown in gardens for home use and for sale in city markets. Manufacturers of meat products have from time to time grown the crop for their own use, but in normal times almost the entire supply needed is imported from southeastern Europe. During the war, when supplies were not obtainable from the usual sources, sage was grown in various localities in the United States with considerable success.

Sage makes its best growth in a rich clay loam with a good supply of nitrogen, but it will grow in a wide range of soils of reasonable nitrogen content provided they are well drained. Excessive moisture in the



FIGURE 43.—Pokeroot.

soil during freezing weather results in winterkilling in the Northern States. Sage will withstand below-zero temperatures if it is protected by snow or a mulch of leaves or straw.

Sage may be propagated by stem cuttings, which can be rooted easily in sand and then planted 12 to 18 inches apart in rows 3 feet apart. For larger plantings seed may be drilled directly in the field about three-fourths of an inch deep in rows 3 feet apart early in spring, as soon as the ground is warm. The plants are later thinned to the desired spacing. The first-year crop from such a planting is light. By sowing the seed in a coldframe or hotbed the seedlings can be transplanted to the field by hand or set by the transplanting machine used



FIGURE 44.—Sage.

for tobacco or vegetable crops. One pound of good viable seed sown in a coldframe should produce 10,000 to 15,000 seedlings, which is sufficient to plant an acre with the spacing mentioned. Light cultivation is necessary, and all weeds must be removed because they give an undesirable flavor to the final product.

Only the leaves and the small tops of the sage plant can be sold at the best market price. These are obtained by either hand-picking the

leaves or by cutting the crop with a mower and stripping the leaves from the stem. Both methods involve considerable hand labor. No satisfactory labor-saving method of harvesting this crop has been devised. A small crop can be obtained the first year, and thereafter the same planting should produce a crop for 2 to 6 years if grown in a climate where the plants will survive the winter. After the first year it is sometimes possible to harvest more than one crop in the same season.

Sage must be dried in the shade by any means by which the natural color is retained, otherwise the product is not readily accepted on the market. Drying may be hastened by a slow fire in a drying shed or common tobacco-drying barn. Sage loses its flavor with age and for this reason it is desirable to bale and market the product soon after the harvest. The quality of American sage is usually considered equal to that of the best grade from southeastern Europe.

In the first year the yield is usually small, ranging from 200 to 600 pounds of dried leaves per acre. Much depends on getting good seedlings planted in the field early in spring and on favorable growing conditions during the early part of the season. In the second and subsequent years 1,500 to 2,000 pounds can be obtained if the crop can be cut at least twice in a season.

Sage grows well in the United States in the regions from Wisconsin south to central Georgia and throughout the eastern coastal States. The possibilities of production under irrigation are not known. Usually a hot, dry climate produces an inferior product. It is reported that in the northern part of the United States the plant usually produces more leaf and less flowers and seed than in the Southern States. Sage could be grown to advantage by growers of tobacco and of some other crops for which hotbeds, transplanting machinery, and some type of drying barn or shed are available. The need for a large immediate investment could thus be reduced. Sage is frequently damaged or killed by a number of diseases. Their nature and the conditions that favor their spread in the field are not well understood.

More than 1,500,000 pounds of sage are used annually in this country. This production would require 1,500 acres, but the returns are attractive only when the product is not available from abroad. During the war the price was high for a while, but the use of a native sage from California and the importation of an inferior variety from accessible Mediterranean regions soon caused a decline.

Senega

Senega (*Polygala senega*) (fig. 45), known also as senega snakeroot and senega root, is a small native perennial occurring in rocky woods in the Eastern States and Canada. The root is used in medicine.

Senega can be grown in any soil that contains a fair proportion of leafmold. Shade is not essential, although the plant thrives in partial shade in open hardwood forests. To propagate from seed it is necessary to plant seed that has been stratified by mixing it with sand and burying it in boxes or flowerpots in moist soil until the following spring, when it may be sown in seedbeds or shallow boxes of loam and leafmold. The seedlings when old enough to be handled safely can be readily transplanted to the permanent beds and set in rows to facilitate cultivation. The plant can also be propagated from roots, which may be obtained from dealers or collected from the wild plants in fall or early spring.



FIGURE 45.—Senega.

In cold situations the plants will probably need protection during the first winter after transplanting. A light covering of straw or pine needles will be sufficient to protect them from severe frost.

The plant grows slowly, and experiments thus far indicate that about 4 years are required to obtain marketable roots. The roots should be dug in fall, thoroughly cleaned, and dried. There are no reliable data on the probable yield.

Sesame

Sesame (*Sesamum indicum*) (fig. 46), an erect-growing annual, is extensively cultivated in warm regions in many parts of the world.



FIGURE 46.—Sesame.

The seed, after special preparation, is used on bread and rolls to which it gives a pleasant nutty flavor. It contains an excellent edible oil that is used in various ways in the food industries in this country.

The plant requires a warm climate and a fairly long growing season to mature its seed. It thrives best on light sandy loam. It is grown only from seed, which must be planted as early in spring as possible to assure full maturity of the crop before early fall frosts. In some countries the seed is broadcast, but the preferred practice is to plant it with a seed drill in rows 3 to 4 feet apart. The seedlings may be allowed to stand thick in the row or thinned when 5 inches high to stand up to 12 inches apart. When thinned the plants branch and produce several seedstalks, but experiments have shown that this does not increase the yield of seed. Shallow cultivation to control weeds is necessary.

The seed pod of sesame opens when fully ripe, and the seed falls out with the slightest movement of the stalk. This excessive shattering makes it very difficult without heavy loss of seed to harvest a fully ripe crop with mechanical equipment. The progressive ripening of the seed pods from the base of the stalk toward the top adds to the difficulty of harvesting. If the harvest is delayed until most of the pods are ripe, all those from the middle of the stalk down will have shed their seed. Experiments have shown that if the stalk is cut when the seed pods near the top are about fully grown but still green, the seed in these pods matures. It is slightly smaller but normal in viability and oil content. The best time to harvest the crop is therefore when this stage is reached. Even so, some of the seed will be lost from shattering and further loss will result from failure of the more immature seed to ripen.

At the stage mentioned, a corn binder can be used and the bundles shocked like corn. When fully cured the entire shock should be lifted as carefully as possible into a tight-bottomed wagon. The seed can be easily removed from the straw by threshing and can be cleaned with the seed-cleaning machines ordinarily used for small grains. It should be stored in places well protected from rodents, to which it is very attractive.

The yield of seed is determined by seasonal conditions and the care used in harvesting. The yield should be 500 to 800 pounds per acre, though much larger yields have been obtained at times on small areas in California.

Sesame is well adapted to all the Southern States. It has escaped to the southeastern coastal area, where it is a source of food for wild fowl; and its culture has been attempted under irrigation in central and southern California and Arizona, where several hundred acres were grown in 1 year with but little success. The clear dry weather in this region is definitely favorable to the crop. It has also been grown on a limited scale in Nebraska. Its culture is relatively simple, but the great difficulty of harvesting without excessive loss of seed from shattering has discouraged production. The plant is subject to several diseases that cause much damage at times. The gross returns, on the basis of normal market value, would be small.

Spearmint

Spearmint (*Mentha spicata*) (fig. 47) is a well-known mint frequently found growing wild throughout the eastern half of the United States.



FIGURE 47.—Spearmint.

The leaves and flowering tops are widely used for seasoning meats and beverages, and the volatile oil distilled from the whole herb is used for flavoring chewing gum and dentifrices and in medicine.

Spearmint is easily grown in any fertile soil that is fairly moist and, like peppermint, is well adapted to reclaimed swamplands. It is propagated, cultivated, harvested, and distilled for the production of the volatile oil in the same way as peppermint. To prepare the dry herb for market the leaves and flowering tops are collected when the first

flowers appear and are then carefully dried in the shade. The demand for the dried herb is small, but up to 14,000 acres are grown annually for oil in Indiana and Michigan, with a production of about 450,000 pounds of oil. The yield of oil is generally a little higher than that of peppermint and will average about 33 pounds per acre.¹⁴



FIGURE 48.—Stramonium.

Stramonium

Stramonium (*Datura stramonium*) (fig. 48) is a poisonous annual and occurs as a common barnyard weed in most sections of the United States. The leaves and flowering tops are used medicinally and as a

¹⁴ For complete information on the growing of spearmint see Farmers' Bulletin No. 1988, Mint Farming.

source of atropine, an important medicinal alkaloid. There is also a limited use for the seed for the same purpose. Although the plant occurs as a weed in this country the quantity entering the market from that source in normal times is apparently very limited, probably owing to the low price offered for it.

Although stramonium grows wild on a variety of soils, it thrives best under cultivation on those that are rich and rather heavy. The plant is readily propagated from seed, which is sown directly in the field with a seed drill in spring in rows 3 feet apart. Germination is usually good. When the plants are several inches high they are thinned to stand 6 to 10 inches apart in the row. Cultivation sufficient to control weeds is necessary for good growth.

In most localities the plants are attacked by leaf-eating insects, the common potato beetle being especially destructive. These often attack when the plants are still small and can easily destroy the crop unless proper protective measures are taken. Some protection is obtained by dusting the plants with lime, but usually spraying or dusting with insecticides is necessary.

The leaves and tops may be picked by hand when the plants are in flower. This method requires much hand labor and under most circumstances is too expensive. A more economical way is to cut the plants below the point where they are branched and dry them on a barn floor or in an artificially heated curing room. When dry, the leaves and small stems can readily be threshed or flailed from the large stalks in any convenient way. The material thus obtained is entirely satisfactory for the extraction of alkaloids but may not be so acceptable to the trade in some cases as the less broken hand-picked tops. The cured material should preferably be baled. In regions where continuous clear hot weather prevails at harvesttime the crop can probably be cured in the field by some procedure that will greatly reduce the cost. Any ripe seed at this time can be separated from the mechanically threshed or flailed-off material with a fanning mill or similar device. If the leaves are hand-picked in the field a much larger seed crop can be obtained because the seed capsules, most of which are still immature, may then be permitted to ripen.

Under good conditions yields of 1,000 to 1,500 pounds of dry leaf per acre and 500 to 2,000 pounds of seed may be expected. The yield of seed will depend on the method used for harvesting the leaves and tops.

Stramonium can be grown under cultivation in practically all parts of the country, including the irrigated sections of the Pacific coast and in the Southwest. In the Northern States the growing season is sometimes too short to permit the seed to mature. Only about 250 acres would be required to grow the quantity of herb annually imported. During periods when its price is high the quantity collected from wild plants is much greater than usual, thus reducing the market outlet for the products from the cultivated plant. The crop has not been found profitable when adequate supplies are available from foreign sources.

Tansy

Tansy (*Tanacetum vulgare*) (fig. 49) is a European perennial plant that has escaped from gardens in this country and occurs as a weed along fence rows and roadsides. Its leaves, flowering tops, and essential



FIGURE 49.—Tansy.

oil are in some demand for medicinal purposes. In Michigan and Indiana mint growers annually grow about 100 acres of this crop for the production of the oil.

Tansy grows well on almost any good soil. It may be grown from seed sown early in spring in the field or in seedbeds, and the seedlings later transplanted to the field. In the localities where it is grown as an oil crop new fields are started with small plants pulled from established fields when they are 5 or 6 inches high. These are set in rows about 3 feet apart with transplanting machines. After 1 year the crop spreads over the field and thereafter is not cultivated but hand-weeded as necessary. In some cases the fields are maintained in that way for many years.

When grown for the sale of the herb the plants are cut in summer when in full flower, the leaves and tops separated from the stems, and

dried without exposure to the sun. For the production of the oil the crop is usually harvested with a grain binder, cured partly in the shock, and then distilled. It can also be cut like mint with a mower and left to dry in the swath for several days.

A yield of about 2,000 pounds of dry leaves and flowering tops per acre can be obtained under good conditions. The yield of oil varies greatly—as much as 40 pounds per acre has been reported, but on old fields generally the average is not more than 10 pounds. Tansy herb and oil are in very limited demand, and increases in their production would reduce their market value.

Tarragon

Tarragon (*Artemisia dracunculus*) is a vigorous perennial plant native to western Asia. It is widely cultivated in southern Europe for its aromatic leaves, which are used for flavoring various food products, and for its volatile oil, known as estragon oil, also used as a flavoring agent.

The cultivated plant rarely produces seed but is easily propagated by root or crown divisions. The root divisions are set early in spring spaced 1 foot apart in rows 3 feet apart. The large crown that develops should be taken up and subdivided after 3 or 4 years.

The leaves and tops may be harvested at intervals during the growing season and dried carefully in subdued light to retain the color. The dried product must be stored in tight containers to prevent loss of flavor.

There has been no experience in this country in the growing of tarragon as a volatile-oil crop. In Europe two harvests are obtained. The flowering plants are cut to the ground in July, and new growth develops for a second harvest in September. The oil is distilled like most other volatile oils. A thousand pounds of the herb yields 3 to 3.5 pounds of oil, but there are no available estimates of the yield of oil per acre.

Thyme

Thyme (*Thymus vulgaris*) (fig. 50) is a small shrubby, sometimes prostrate, perennial plant native to southeastern Europe. The herb is widely used for flavoring foods, and the volatile oil obtained from the herb by steam distillation is used for medicinal purposes, for flavoring medicinal preparations and dentifrices, and to a minor extent in perfumes. A number of varieties of this species, also other species, especially *T. serpyllum*, are likewise used as savory herbs. Thyme is frequently grown in gardens for home use and for sale in city markets, but it has not been cultivated as a farm crop in this country.

Thyme prefers a mild climate and a mellow upland soil but will persist to a marked degree on poor dry soils. It may be propagated from seed or cuttings. Seed is drilled in the field early in spring in rows about 3 feet apart, or the seedlings may be started in the greenhouse or an outdoor seedbed and later set in the field spaced 18 inches apart in the row. Crown divisions and cuttings rooted under glass in sand are additional means of propagation. The plants require cultivation throughout the growing season. Since they have a tendency to become woody, it is good practice to renew the planting in 2 or 3 years.

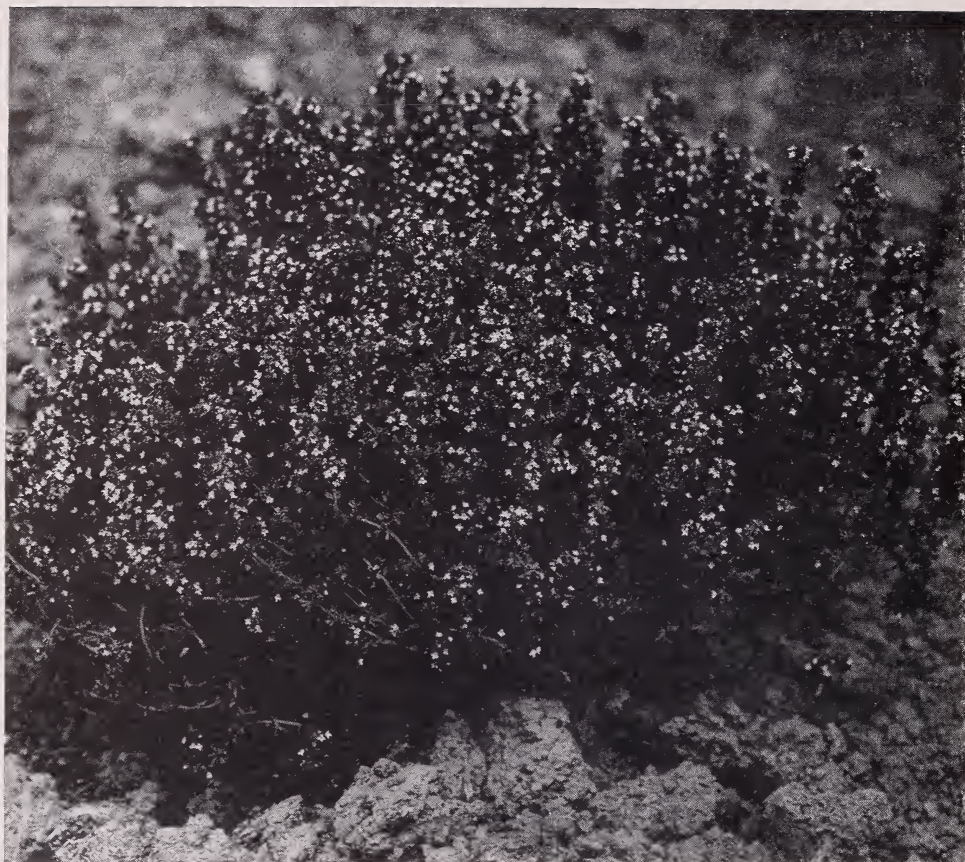


FIGURE 50.—Thyme.

Thyme herb is harvested when the plant is in bloom. When the crop is grown in small plots the herb is cut with hand shears so that several inches of the tender stems are included. For large areas this method is too slow and costly, but a practical method of mechanized harvesting has apparently not been developed. The chief aim is to limit the number of stems in the herb when cut, but the removal of excess stems by some practical procedure after the herb has been dried may be possible. The cut material must be dried carefully in the shade to preserve the color, preferably by spreading it thinly in trays with muslin or fine wire mesh bottoms.

The yield of thyme herb is relatively small in the first year but increases as the plants get larger and become better established. Few estimates based on large plantings are available, but under good conditions 1,000 to 2,000 pounds of dry herb per acre can be expected. The yield of oil per acre is not likely to exceed 20 pounds.

Thyme appears to be well adapted to the milder sections of the North and to some localities on the west coast. The fact that the plant is hardy and apparently not subject to much damage by disease or insects is a favorable factor in considering its commercial culture. Lack of an economical method of harvesting, however, and the small yield in the first season do not make this crop attractive under normal market conditions.

Valerian

Valerian (*Valeriana officinalis*) (fig. 51), native to Europe and northern Asia, is a hardy herbaceous perennial, well known under the name of "garden heliotrope" and often grown as an ornamental plant. It has also been cultivated as a drug plant in New York and in parts of



FIGURE 51.—Valerian.

New England. The dried roots (rhizome and roots) are the marketable drug.

Valerian may be grown in a variety of soils but thrives in a rich and rather heavy loam that is well supplied with moisture. It is readily propagated by dividing the old roots in fall or spring and setting the divisions about 1 foot apart in rows 2 to 3 feet apart. If they are set early enough in fall to become well established before frost, a good crop may usually be harvested the following fall. Plants may also be grown from seed, which is preferably sown in a well-protected seedbed in the garden as soon as it is ripe. Early in spring the seedlings are transplanted to the field and set spaced as the root divisions. Growth is favored by a liberal application of manure, well worked into the soil before the plants are set out. Thorough cultivation is essential.

The roots of the plants propagated by division may be dug in the fall of the first year but the yield will probably be small. Those of seedling plants do not usually reach a marketable size before the end of the second growing season. They are washed free of soil and thoroughly dried by use of artificial heat if necessary. Drying is facilitated by slicing the thick portions of the roots lengthwise. Under good conditions a yield of 2,000 pounds of dried roots per acre can be expected at the end of the second year.

Vetiver

Vetiver, or cuscus grass (*Vetiveria zizanioides*) (fig. 52), is an aromatic perennial grass native to southern Asia. It is occasionally cultivated in this country in the warmer parts of the Gulf Coast States as an ornamental and also for its aromatic roots, which are often used to



FIGURE 52.—Vetiver.

impart a fragrance to clothing. An oil distilled from the roots is used in the manufacture of perfumes.

Vetiver will grow in almost any soil, but light sandy soil is preferred because it makes the harvesting of the roots less difficult. It is propagated by using divisions of old clumps, which are set in the field, in fall or spring, about 4 to 5 feet apart each way. Vetiver grows in large bunches, 6 to 8 feet high, the numerous roots spreading horizontally about 2 feet on all sides of the plant.

Harvesting the roots, which usually takes place in November, is a laborious operation. When grown in small plots the large individual plants are dug by hand. On a larger scale mechanical devices, such as tree lifters or modified plows, have been used to loosen the plants or partially lift them out of the ground. In any case the soil must then be removed by whatever means is most practical and the roots cut off close to the crown and thoroughly washed. They may be dried in the open air, but it is preferable to dry them in a closed room at a low temperature, since they lose their fragrance if exposed to the hot sun or to freely circulating air.

The distillation of the oil from the roots is much more difficult than the distillation of most other volatile oils and requires special equipment. It has not been successfully done by growers of the crop in the United States.

Vetiver is grown in small plots in the vicinity of New Orleans, and the roots are sold in the stores and markets of that city. The demand for the roots is largely local, and attempts to enlarge the market have not been successful. Yields at the rate of 600 to 1,000 pounds of dry roots per acre have been obtained.

Wintergreen

Wintergreen (*Gaultheria procumbens*) (fig. 53) is a low-growing evergreen plant with a creeping stem. It is found in scattered localities in woods and clearings from eastern Canada southward to the Gulf States, especially at elevations of 2,000 feet or more, but its collection in quantity in the situations in which usually found is somewhat difficult. The dry herb and the volatile oil distilled from it are marketable products. Both are used medicinally, but the oil is used to a greater extent for flavoring.

Like other woodland plants, wintergreen thrives only in partial shade and plantings should be made in a grove or under a specially constructed shade, such as is used for ginseng or goldenseal. A fairly good growth may be expected in soil that is thoroughly mixed with leaf-mold to a depth of 4 inches or more. For propagation, divisions of wild plants can be used, set in fall or spring about 6 inches apart each way in their permanent location.

Wintergreen is usually gathered in October, at the end of the growing season. The plants are carefully dried and packed in bags or boxes for marketing. For the production of the volatile oil they are chopped and soaked in water for about 24 hours and then distilled with steam. No actual figures are available on the quantity of oil produced in recent years, but there has been a steady decline in the importance of this small industry. The oil is obtained entirely from plants growing wild in a few scattered localities in the mountainous sections of the Eastern States. The growing of wintergreen for either the herb or the oil is not likely to be profitable.



FIGURE 53.—Wintergreen.

Wormseed (American)

American wormseed (*Chenopodium ambrosioides*) (fig. 54) is a coarse, usually annual weed, occurring commonly in waste places and often in cultivated ground throughout the eastern and southern parts of the United States. The seeds (fruits) and the volatile oil distilled from the fruiting tops of the plant are employed in medicine in the control of intestinal worms, especially in veterinary practice.

This plant grows well under cultivation in almost any soil, but a good sandy loam is preferred. It is now cultivated for oil production only in a small area in central Maryland, mainly in Carroll County. The cultivated form of the plant does not grow so tall as the wild plant, but produces more seed. Since the seed covering contains more oil than other parts of the plant this form gives the highest yield of oil. The seed is sown about March 1 in well-prepared beds like those used for



FIGURE 54.—Wormseed.

growing tobacco. Between May 15 and June 15, when the seedlings are 4 to 5 inches tall, they are transplanted with machines to stand about 10 inches apart in rows about 3 feet apart. The soil is kept entirely free from weeds by shallow cultivation throughout the growing season.

Harvesting is usually begun early in September or as soon as the seeds are black, but before the plants have turned brown. If harvesting is delayed until the plants are fully mature there will be considerable loss through shattering of the seed and consequently a lower yield of oil. The plants are cut with a mower with buncher attachment or with an old-style grain reaper and are left in the field until partly dry but not dry enough to shatter. In this condition they are distilled with steam in equipment similar to that used for other volatile-oil crops. The distillation must be conducted carefully because the rate of distillation and the temperature of the condenser water have an important effect on the medicinal quality of the oil obtained. Many growers who have only a few acres haul their crops to stills operated by other growers, who distill it at a fixed price per pound of oil obtained.

If the crop were grown entirely for the seed about 1,000 pounds of the seed per acre could be obtained. In favorable years the yield of oil

may be 40 pounds to the acre, but generally it is much less on some of the acreage, owing usually to poor stands. In 1939, 240 farmers grew on the average 4 acres each and produced 38,000 pounds of the oil. The market for the oil is steady, but limited from year to year, since it has only the one use mentioned. It is subject to overproduction, with a resulting reduction in market value. For this reason an increase in acreage in the region where it is now grown or the introduction of the crop elsewhere is inadvisable. Although there is some market demand for seed for use in condition powders for livestock, the crop is not especially grown for the seed. This accumulates in considerable quantities when the crop is hauled to and loaded into the stills and is sometimes marketed as such.

Wormwood

Wormwood (*Artemisia absinthium*) (fig. 55) is a hardy herbaceous Old World perennial that has escaped from cultivation in this country and now occurs as a weed in many localities in the Southern States. It is grown commercially on a small scale in Michigan and Oregon. The volatile oil, which is used medicinally, is distilled from the herb and is



FIGURE 55.—Wormwood.

the principal marketable product, but the dried leaves and tops also have some medicinal use.

Wormwood will grow in almost any soil, but it gives best results in deep, rich, moderately moist loams and muck soils, and it is on these that much of the commercial acreage is grown. The seed is small and should be sown on the surface of the soil in coldframes or seedbeds and lightly covered with very fine sandy soil. The plants are easily lifted when about 5 to 6 inches high and can be transplanted in moist weather with good results at almost any time during the growing season. If the seed is sown in fall the seedlings can be set in the field any time during the following summer. They are set with transplanters about 8 to 12 inches apart in rows 3 or 4 feet apart and are well cultivated. A fair crop of the herb can be expected the first year after planting and full crops for successive seasons thereafter, so long as the crop remains in good condition.

The plants are harvested with a grain binder when in full bloom. Because the stalks are coarse and tough a binder with a power take-off from a tractor must be used. The bundles are placed in shocks, and when the material has partly dried it is distilled like mint for the production of the oil. If the herb is to be marketed the cut plants are spread out and dried in the shade to assure good quality, and when entirely dry the large stems are removed by any practical method that can be devised.

Yields up to 2,000 pounds of dry herb can be expected under good conditions. The oil yields range from less than 10 to 40 pounds per acre and average about 20 pounds. The crop is grown almost entirely under contract at a fixed price with consumers of the oil. Since the market is limited and the present acreage adequate, any considerable increase in production would be unprofitable.

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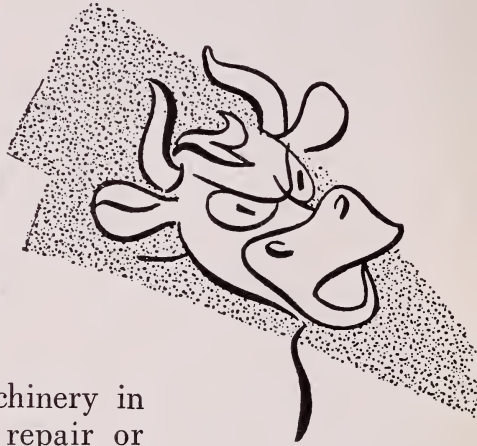
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